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(PCT Rule 92bis.1 and Administrative Instructions, Section 422)

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1. The following indications appeared on record concerning:

[X] the applicant [ ] the inventor [ ] the agent [ ] the common representative

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2. The International Bureau hereby notifies the applicant that the following change has been recorded concerning:

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3. Further observations, if necessary:

4. A copy of this notification has been sent to:

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PATENT COOPERATION TREATY

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To:

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2. The election [X] was

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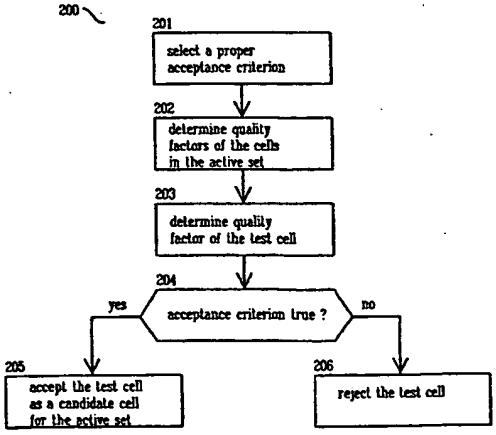

(57) Abstract: A method (200, 300, 400) according to the invention is a method for determining a condidate cell for an active set, where the quality factor of each cell in the active set is determined (202), a quality factor of a test cell is determined (203), and the test cell is accepted (205) as a candidate cell for the active set if an acceptance criterion is fulfilled. The method is characterized in that the acceptance criterion is selected (201) so that for a certain first quality factor of a test cell and for a certain first set of quality factors, consisting of quality factors of the cells in a first active set, the acceptance criterion has the same value as for a certain second quality factor of a test cell and for a certain second set of quality factors, consisting of quality factors of cells in a second active set, when the first quality factor is equal to the second quality factor multiplied with any finite number and the first set of quality factors is the same as a set formed of the quality factors belonging to the second set of quality factors multiplied with the same finite number. The invention relates also to an arrangement, to a mobile station and to a network element where decisions about accepting a cell as a candidate cell for the active set are done.

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Method for determining a candidate cell for an active set

The invention relates in general to cellular networks. In particular the invention relates to soft handovers in cellular networks.

Transmission diversity refers to a situation where at least two transmitters are transmitting the same data flow to a receiver. For example, a mobile station may receive radio transmissions from two base stations of a cellular network simultaneously. One of the advantages of the transmission diversity is that if the quality or strength of one of the received radio transmissions decreases, the quality of some other received transmissions may still be high enough for receiving data reliably.

A situation where a mobile station communicates with more than one base stations simultaneously is called a soft handover. If necessary, for example to ensure a reliable data transmission, a mobile station may be communicating even most of the time with more than one base stations. In certain situations, when the signal of a certain base station is clearly stronger that the signals of other base stations, it may be enough to communicate with one base station only. There has to be a method for deciding with which base stations a mobile station communicates.

Transmission diversity and soft handovers can be supported, for example, in cellular networks that employ Code Division Multiple Access (CDMA) methods. Each transmitter may use its own spreading code in the downlink transmission, and a mobile station wanting to receive data from many transmitters processes the radio signal it receives with the spreading codes corresponding to the transmitters. The code sequences of different connections must be chosen so that they do not correlate and the code sequence of a specific connection has to autocorrelate. Those signals that have been spread using a code sequence that correlates with the code sequence used in receiving the seemingly white noise radio transmission are separated. The receiver has to know the transmitters code sequence and the code sequences must be synchronized. The bits in the code sequence are called chips.

Figure 1 presents a schematic drawing of a cellular network which comprises base stations 101a, 101b and 101c. In Figure 1, these base stations are all connected to a single radio network controller 102 and each base station is in the middle of a cell 111a, 111b and 111c. Figure 1 presents one mobile station 110. The base stations transmit downlink data to mobile stations (arrows 120a, 120b and 120c) and receive uplink data from mobile stations (arrows 121a, 121b and 121c).

In general a base station may comprise many transmitters, each of which transmit a separate radio signal. In systems employing CDMA methods, the transmitters may use different spreading codes. Here term cell is used to refer either to a base station or, if a base station comprises many transmitters, to a transmitter. In a situation where a mobile station receives good quality downlink transmissions from many cells, it has to be decided which cell a certain mobile station communicates with.

Usually the cellular network informs the mobile station of the possible cells, for example, selected based on the location of the mobile station. The information about the nearest cells is called neighbor list. In a cellular network which employs CDMA methods, the neighbor list may comprise the downlink spreading codes of the cells. By taking the spreading codes listed in the neighbor list into use, the mobile station may separate the data flows sent to it from each cell from the radio signal it receives. The neighbor list of the mobile station 110 may comprise, for example, the cells corresponding to base stations 101a, 101b and 101c, assuming that a base station corresponds to one cell.

Usually a pilot signal is transmitted in each cell. This pilot signal carries no changing data, so it can be quite straightforwardly used in estimating the quality of the downlink radio transmission of a certain cell. A mobile station may, for example, estimate the quality of the radio transmission of all the cells in the neighbor list. A suitable parameter for quality estimation is, for example in a cellular system employing CDMA methods, the E_C/I_0 ratio, where E_C is energy per chip and I_0 is the interference. Any other parameter measuring the quality of the signal may also be used.

The cells with which a mobile station communicates form the active set of that mobile station. A radio network controller, for example, directs the downlink data heading to a certain mobile station, to all the cells in the active set. Correspondingly, the mobile station listens to the downlink transmissions of all the cells in the active set. For example, the cells corresponding to base stations 101a and 101b can form the active set of the mobile station 110.

When the mobile station changes its location or the qualities of the downlink radio transmissions of the neighboring cells change for some other reason, it may be necessary to modify the active set. A cell may be added to or removed from the active set, or a cell in the active set may be replaced with another cell. This replacement is usually called branch replacement.

There has to be a criterion for accepting a new cell for the active set. The CDMA2000 RTT description, for example, defines the following criterion for a test cell to be accepted to the active set. The cell may then be added to the active set or, in case of branch replacement, it may replace the worst quality cell in the active set. If the quality factor, for example the E_C/I_0 ratio, is marked with P_i for each cell i in the active set, an acceptance limit Q can be calculated by

$$Q = \max\left\{S \cdot 10\log_{10}\left(\sum P_i\right) + A, T\right\}$$

where S, A and T are parameters. As can be seen from the formula for Q, the value of Q is expressed in dB and the quality factor P_i is a plain number. It is checked if a certain cell with quality factor P_T is a proper candidate for the active set by comparing $10\log_{10} P_T$ to Q. If $10\log_{10} P_T$ (i.e. P_T expressed in dB) exceeds Q, then the cell can be added, for example, to the active set. Parameter T ensures that even if the quality factors P_i of the cells currently in the active set are poor, a cell having P_T (expressed in dB) less than T is never accepted as a candidate cell.

There may be other conditions, for example that the active set may not be modified too frequently, that hinder the adding of a new cell to the active set. All neighboring cells not belonging to the active set, for example, may be tested each time the neighbor list changes, and the cells whose quality factor does exceeds the acceptance criterion may be considered to be added to the active set.

The problem with the current acceptance criterion is that it does not ensure proper acceptance decisions when the value of S is different from 0 or 1. Let us consider two examples, when the following values for the parameters are set: $S = 2$, $A = -6.0$ dB and $T = -6$ dB. In the first example, the active set contains two cells, each of which has the quality factor value 1, i.e. $P_1 = 1$ and $P_2 = 1$. The acceptance limit in this example is $Q = 0$ dB, i.e. a cell having a quality factor of 1 can be, for example, added to the active set. This is an acceptable decision, because the cell has the same quality factor as the cells in the active set.

In the second example the active set contains also two cells, and now the quality factors are $P_1 = 3$ and $P_2 = 3$. The acceptance limit in this example is $Q = 9.5$ dB. The quality factors of the cells in the active set are 5 dB, so a cell has to have a quality factor 4.5 dB higher than the cells in the active set to be accepted to the active set. Correspondingly, expressed in absolute values, a cell should have a quality factor $P_C = 9.5$ to be accepted to the active set. Intuitively, the acceptance criterion should also in this second example produce the result that a test cell can be accepted to the active set if the quality factor of the cell is larger than 3.

The current acceptance criterion thus leads to situation where intuitively similar situations produce a different acceptance decision. A further problem with the acceptance criterion is that for an active set whose cells have the same quality factors, from here on called an uniform active set, the acceptance limit is not equal to the quality factor.

The object of the invention is to present a method for determining a candidate cell for the active set. A further object of the invention is to present a method where similar active sets and test cells produce the same acceptance decision. Further, it is advantageous that the method for determining a candidate cell accepts a cell whose quality factor is equal to the quality factor of an uniform active set.

The object of the invention is achieved by selecting the acceptance criterion so that it is indifferent to the absolute values of the quality factors.

A method according to the invention is a method for determining a candidate cell for an active set, where

- the quality factor of each cell in the active set is determined,
- a quality factor of a test cell is determined, and
- the test cell is accepted as a candidate cell for the active set if an acceptance criterion is fulfilled, and the method is characterized in that the acceptance criterion is selected so that for a certain first quality factor of a test cell and for a certain first set of quality factors, consisting of quality factors of cells in a first active set, the acceptance criterion has the same value as for a certain second quality factor of a test cell and for a certain second set of quality factors, consisting of quality factors of cells in a second active set, when the first quality factor is equal to the second quality factor multiplied with any finite number and the first set of quality factors is the same as a set formed of the quality factors belonging to the second set of quality factors multiplied with the same finite number.

A method according to the invention is a method for determining a cell to be removed from the active set, where

- the quality factor of each cell in the active set is determined,
- a rejection criterion is evaluated using the cell having the smallest quality factor as a test cell and a temporary set, which contains the cells of the active set except the cell having the smallest quality factor, and
- the test cell is removed from the active set if a rejection criterion is fulfilled, and it is characterized in that the rejection criterion is selected so that for a certain first quality factor of a test cell and for a certain first set of quality factors, consisting of quality factors of cells in a first temporary set, the rejection criterion has the same value as for a certain second quality factor of a test cell and for a certain second set of quality factors, consisting of quality factors of cells in a second temporary set, when the first quality factor is equal to the second quality factor multiplied with any finite number and the first set of quality factors is the same as a set formed of the quality factors belonging to the second set of quality factors multiplied with the same finite number.

The invention relates also to an arrangement for determining a candidate cell for an active set comprising

- means for determining a quality factor for a test cell and
- means for determining quality factors for the cells in the active set, which arrangement is characterized in that it further comprises
- means for selecting an acceptance criterion so that for a certain first quality factor of a test cell and for a certain first set of quality factors, consisting of quality factors of cells in a first active set, the acceptance criterion has the same value as for a certain second quality factor of a test cell and for a certain second set of quality factors, consisting of quality factors of cells in a second active set, when the first quality factor is equal to the second quality factor multiplied with any finite number and the first set of quality factors is the same as a set formed of the quality factors belonging to the second set of quality factors multiplied with the same finite number and
- means for deciding about the acceptance of the test cell as a candidate cell for the active set using the acceptance criterion.

A mobile station according to the invention comprises

- means for determining a quality factor for a test cell and
- means for determining quality factors for the cells in the active set, and it is characterized in that it further comprises

- means for selecting an acceptance criterion so that for a certain first quality factor of a test cell and for a certain first set of quality factors, consisting of quality factors of cells in a first active set, the acceptance criterion has the same value as for a certain second quality factor of a test cell and for a certain second set of quality factors, consisting of quality factors of cells in a second active set, when the first quality factor is equal to the second quality factor multiplied with any finite number and the first set of quality factors is the same as a set formed of the quality factors belonging to the second set of quality factors multiplied with the same finite number and
- means for deciding about the acceptance of the test cell as a candidate cell for the active set using the acceptance criterion.

The invention relates to a network element comprising
- means for determining a quality factor for a test cell and
- means for determining quality factors for the cells in the active set, which network element is characterized in that it further comprises
- means for selecting an acceptance criterion so that for a certain first quality factor of a test cell and for a certain first set of quality factors, consisting of quality factors of cells in a first active set, the acceptance criterion has the same value as for a certain second quality factor of a test cell and for a certain second set of quality factors, consisting of quality factors of cells in a second active set, when the first quality factor is equal to the second quality factor multiplied with any finite number and the first set of quality factors is the same as a set formed of the quality factors belonging to the second set of quality factors multiplied with the same finite number and
- means for deciding about the acceptance of the test cell as a candidate cell for the active set using the acceptance criterion.

In a method according to the invention, the quality factors of the cells in the active set are determined. Further, the quality factor of a test cell not in the active set but, for example, in the neighbor list is determined. The choice of the quality factors used in a method according to the invention is not restricted. The term accepting a test cell as a candidate cell for the active cell refers to a situation, where a mobile station or the cellular network notices that a certain cell has good enough quality factor, for example, to be added to the active set. The acceptance of a test cell as a candidate cell may trigger, for example, the transmission of the transmission quality reports from a mobile station to the cellular network. Thereafter the cellular network may decide whether the active set is modified.

In the method according to the invention, the acceptance criterion is selected so that it fulfills the following condition. The acceptance criterion Q' for a test cell having a quality factor P_T and for an active set having n cells, whose quality factors are P_1, P_2, ..., P_n, is $Q'(P_T, P_1, P_2, P_3, ...)$. The value $Q'(P_T, P_1, P_2, P_3, ...)$ is equal to the value of acceptance criterion for a test cell having a quality factor aP_T and for an active set having n cells, whose quality factors are aP_1, aP_2, ..., aP_n. Here a is any infinite scalar number. The condition for the acceptance criterion can be written as

$$\forall a \quad Q'(aP_T, aP_1, aP_2, aP_3, ...) = Q'(P_T, P_1, P_2, P_3, ...).$$

The quality factor of the test cell and the quality factors of cells in the active set are not restricted, the condition holds for any values of P_T and P_i, where P_i is the quality factor of cell i in the active set. An example of a acceptance criterion fulfilling the condition is the following criterion where geometric mean is employed

$$Q'(P_T, P_1, P_2, ...): \quad P_T > \sqrt[n]{\prod P_i}$$

because $Q'(aP_T, aP_1, aP_2, aP_3, ...)$ is

$$Q'(aP_T, aP_1, aP_2, ...): \quad aP_T > \sqrt[n]{\prod aP_i} = \sqrt[n]{a^n}\sqrt[n]{\prod P_i} = a\sqrt[n]{\prod P_i}.$$

If for a certain value of P_T, $Q'(P_T, P_1, P_2, P_3, ...)$ is true, then $Q'(aP_T, aP_1, aP_2, aP_3, ...)$ is also true. In other words, if a test cell having quality factor P_T is accepted as a candidate cell for the active set whose cells have quality factors P_1 and P_2, a test cell having quality factor aP_T is accepted as a candidate cell for the active set whose cells have quality factors aP_1 and aP_2. It is possible to use only some of the quality factors of the cells in the active set in the acceptance criterion, but typically the quality factors of all cells in the active set are used.

In one embodiment of the invention said acceptance criterion involves a function, whose value depends at least on quality factors of first cells in the active set and on certain parameter values. Said acceptance criterion procudes a same value for said first quality factor of a test cell, said first set of quality factors and first parameter values as for said second quality factor of a test cell, said second set of quality factors and the same first parameter values, said first parameter values being any parameter values.

It may, however, be easier to normalized all the quality factors with a certain number and then use the normalized quality factors. The acceptance decision may, for example, be a function having the normalized quality factors as variables. The

normalization factor has to be chosen so that its relative value when compared to the quality factors of the cells in the active set is same for all active sets. The normalization factor may be, for example, the average of the quality factors of the cells in the active set.

It is also possible to use similar methods when deciding about removing a cell from the active set. In this case the cell in the active set having the smallest quality factor is compared to the rest of the active set. Usually the rejection criterion is selected somewhat higher than the acceptance criterion, in order to avoid frequently removing from the active set and adding to the active set a same cell. The acceptance and rejection criterion may employ same mathematical function and parameters, but the parameter values are selected in a proper way.

The diversity gain depends on the relative strengths (for example, quality factors) of the cells in the active set. The main advantage of the method according to the invention is that the acceptance decision depends on the relative sizes of the quality factors and does not pay attention only to the absolute values of the quality factors. The acceptance decisions thus reflect the changes in the diversity gain.

A further advantage of the method according to the invention is that when relative sizes of the quality factors are used, it is easier to predict how a certain acceptance criterion, for example a certain function, behaves. It is enough to study a limited number of examples when, for example, parameter values for an acceptance criterion are selected. Even a further advantage is that the current methods for determining a candidate cell for the active set can be quite easily updated to a method according to the invention. No further measurement results, for example, are needed that are currently available.

The method according to the invention may be carried out, for example, periodically. When a mobile station, for example, detects a new candidate cell for the active set, it may transmit a request for handover or a request for update of the active set to the cellular network. The method according to the invention may also be triggered by a certain event, for example, by the update of the neighbor list. The method according to the invention does not specify if the active set is modified after finding a candidate cell to the active set.

Further embodiments of the invention are described in the accompanying dependent claims.

The invention will now be described more in detail with reference to the preferred embodiments by the way of example and to the accompanying drawings where

Fig. 1 shows a schematic drawing of the radio access network of a cellular system,

Fig. 2 shows a flowchart of method according to a first preferred embodiment of the invention,

Fig. 3 shows a flowchart of method according to a second preferred embodiment of the invention,

Fig. 4 shows a flowchart of method according to a third preferred embodiment of the invention, and

Fig. 5 shows a schematic drawing of an arrangement, a mobile station and a network element that employ a method according to the invention.

Above in conjunction with the description of the prior art reference was made to Figure 1. The same reference numerals are used for corresponding parts in the figures.

Figure 2 presents a flowchart of a method 200 according to a first preferred embodiment of the invention. In step 201 a proper acceptance condition is selected. In a method according to the invention, the acceptance criterion Q' has to be of form $Q'(aP_T, aP_1, aP_2, aP_3, \ldots) = Q'(P_T, P_1, P_2, P_3, \ldots)$, where P_i is the quality factor of cell i in the active set, P_T is the quality factor of the test cell, and a is a scalar. The acceptance criterion can be, for example, that the quality factor of the test cell needs to exceed the average of the quality factors of the cells in the active set

$$P_T > \frac{1}{n}\sum P_i,$$

where n is the number of cells in the active set. Linear combinations of the values P_i and a geometrical mean $\sqrt[n]{\prod P_i}$ are examples of functions that can be used in the acceptance criterion Q' according to the first preferred embodiment of the invention.

In step 202 quality factors for the cells belonging to the active set are determined. This may happen, for example, so that a mobile station determines the E_C/I_0 ratio for the pilot signals of the cells in the active set. In step 203 the quality factor of a test cell is determined. The test cell may be, for example a cell in the neighbor list that does not belong to the active set. If the acceptance criterion is true (step 204), and the test cell is accepted in step 205 as a candidate cell for the active set. If the quality factor is not large enough, then the test cell is rejected (step 206).

Figure 3 presents a flowchart of a method 300 according to a second preferred embodiment of the invention. In this method, the quality factors of the cells in the active set and the quality factor of the test cell are normalized by dividing them with a certain normalization factor P_n. The normalization factor has to be chosen for each active set so that its ratio to the quality factors of the cells in the active set is the same for all active sets, i.e. for an active set having quality factors $P_1, P_2, P_3, \ldots$ the normalization factor is P_n and for an active set having quality factors $aP_1, aP_2, aP_3, \ldots$ the normalization factor is aP_n. For example, the average of the quality factors of the cells in the active set may be used as a normalizing factor P_n, or the minimum quality factor or the maximum quality factor of the cells in the active set.

The advantage of using normalized quality factors is that the acceptance criterion Q' may have any functional form and it still obeys $Q'(aP_T, aP_1, aP_2, aP_3, \ldots) = Q'(P_T, P_1, P_2, P_3, \ldots)$. For example, the prior art acceptance limit

$$Q = \max\left\{S \cdot 10\log_{10}\left(\sum P_i\right) + A, T\right\}$$

where S, A and T are parameters can be modified to the following acceptance criterion Q'

$$Q': \quad 10\log_{10}\frac{P_T}{P_n} > \max\left\{S \cdot 10\log_{10}\left(\sum \frac{P_i}{P_n}\right) + A, T - 10\log_{10}P_n\right\}.$$

The values for this acceptance criterion are true (when P_T exceeds the condition) and false (when P_T does not exceed the condition).

In Figure 3, the flowchart of the method 300 starts with the same steps 201, 202 and 203 as method 200. A proper acceptance criterion is selected, the quality factors of the cells in the active set and the quality factor of the test cell is determined. Thereafter, in step 301 these quality factors are normalized with a normalization factor P_n. The acceptance criterion in step 302 is determined using the normalized quality factors, for example the functional form presented above may be used for Q'.

In step 303 it is checked if the value for the acceptance criterion is true, and if it is the test cell is accepted as a candidate cell for the active set in step 205. If the value for the acceptance criterion is false, the test cell is rejected in step 206.

Let us study further the method 300 according to the second preferred embodiment of the invention and the presented functional form for Q'. Consider two active sets and the parameter values $A = -6.0$ dB, $S = 2$ and $T = -6.0$ dB. In the first active set

there are two cells whose quality factors are 1 and 1, and in the second active set the quality factors for the cells in the active set are 3 and 3. Let us choose the normalizing factor P_n as the average quality factor of the cells in the active set. The acceptance criterion becomes

$$Q': \quad 10 \log_{10} \frac{P_T}{P_n} > \max\{0 \text{ dB}, -10.8 \text{ dB}\} = 0 \text{ dB}$$

indicating that in both examples the quality factor of the test cell has to be larger than the normalization factor for the test cell to be accepted as a candidate cell for the active set.

Let us consider one further example using the same parameter values for A, S and T. The active set contains in this case two cells, whose quality factors are $P_1 = 1$ and $P_2 = 3$. Let us study the effect of the normalization factor by trying three normalization factors: $P_{n1} = P_{\max} = 3$, $P_{n2} = P_{\text{ave}} = 2$ and $P_{n3} = P_{\min} = 1$. For the first normalization factor the acceptance criterion becomes

$$Q'_1: \quad 10 \log_{10} \frac{P_T}{P_{n1}} > \max\{-3.5 \text{ dB}, -10.8 \text{ dB}\} = -3.5 \text{ dB} \Rightarrow P_T > 0.45 P_{n1} = 1.3.$$

For the second and third normalization factors the acceptance criteria are

$$Q'_2: \quad 10 \log_{10} \frac{P_T}{P_{n2}} > \max\{0 \text{ dB}, -9 \text{ dB}\} = 0 \text{ dB} \Rightarrow P_T > P_{n2} = 2 \text{ and}$$

$$Q'_3: \quad 10 \log_{10} \frac{P_T}{P_{n3}} > \max\{6 \text{ dB}, -6 \text{ dB}\} = 6 \text{ dB} \Rightarrow P_T > 4.0 P_{n3} = 4.$$

The choice of the normalization factor thus clearly affects the acceptance criterion. When using, for example, the minimum quality factor of the cells in the active set as a normalization factor, the criterion becomes more demanding than when, for example, the maximum quality factor of the cells in the active set is chosen. By choosing the normalization factor properly it is thus possible to adjust the behavior of a method according to the second preferred embodiment of the invention. When using the maximum quality factor in normalization, more cells are accepted as candidate cells for the active set.

Figure 4 presents a flowchart of a method 400 according to a third preferred embodiment of the invention. In this method the quality factors of the cells in the active set and the quality factor of the test cell are normalized similarly as in method 300. Further, in this method the acceptance criterion is adjusted so that in a case,

where the active set contains cells which all have the same quality factor, a test cell is accepted as a candidate cell for the active set when its quality factor is larger than the quality factor of the cells in the active set.

As an example, let us again consider the acceptance criterion Q'

$$Q': \quad 10\ \log_{10}\frac{P_T}{P_n} > \max\left\{S\cdot 10\log_{10}\left(\sum\frac{P_i}{P_n}\right)+A, T-10\log_{10}P_n\right\}.$$

When all cells in the active set have the same quality factor p, the sum of the quality factors is equal to np. A test cell having the same quality factor p should fulfill the following condition

$$10\ \log_{10}\frac{p}{P_n} = \max\left\{S\cdot 10\log_{10}\frac{np}{P_n}+A, T-10\log_{10}P_n\right\}.$$

Further, let us first study parameters A and S, and choose T thereafter. This results in equation

$$10\ \log_{10}\frac{p}{P_n} = S\cdot 10\log_{10}\frac{np}{P_n}+A,$$

and the relation between A and S can be written as

$$A = (1-S)\cdot 10\ \log_{10}\frac{p}{P_n} - S\cdot 10\log_{10}n.$$

If the normalization factor P_n is the average/maximum/minimum quality factor of the cells in the active set, for an active set containing cells whose quality factors are equal to p the normalization factor is $P_n = p$. The relation between A and S thus becomes

$$A = (1-S)\cdot 10\ \log_{10}\frac{p}{p} - S\cdot 10\log_{10}n = -S\cdot 10\log_{10}n.$$

If the normalization factor is not equal to p for an active set whose cells all have quality factor p, the first term also contributes to the relation. For example, if the number of cells in the active set is two (i.e. $n = 2$), the relation between the parameter values is $A = -3S$. When $n = 3$, the relation is $A = -4.8S$. The value for parameter T can be chosen so that $T < 0$.

In method 400 in Figure 4, after the acceptance criterion has been selected in step 201 the number of cells in the active set is determined in step 401. In step 402 the acceptance criterion is adjusted for an uniform active set, where all cells have the same quality factor p similarly as explained above. The acceptance criterion may depend at least on the number of cells in the active set and on the choice of the normalization factor. After the acceptance criterion has been adjusted, the method 400 continues similarly as method 300 from step 202 onwards.

Figure 5 present an arrangement 500, a mobile station 510 and a network element 520 where a method according to the invention is implemented. The arrangement for determining a candidate cell for the active set comprises a test cell block 501, where the quality factor for a test cell is determined. It also comprises an active set block 502, where the quality factors for the cells belonging to the active cell are determined. It is advantageous to measure the quality factors of the cells belonging to the active set each time the quality factors are needed, but it is also possible to store the values in memory and update them, for example, periodically.

The arrangement 500 further comprises an acceptance criterion block 503, where the acceptance criterion is selected and possible adjusted. In the decision block 504 the quality factors of the test cell and of the cell belonging to the active set are used to evaluate the acceptance criterion. The blocks may be implemented, for example, using microprocessors and proper program code.

Figure 5 shows how the block of the arrangement may be located to more than one device. In Figure 5, the mobile station 510 comprises block 501 and 502, i.e. it determines the quality factors for the cells in the active set and for the test cell. It may, for example, measure the E_C/I_0 ratio of the pilot signals of neighboring cells. The measurement results may be transferred to a network element 520 of the cellular network. This network element may be in charge of determining if the test cell is accepted as a candidate cell for the active set.

It is also possible that a mobile station comprises the whole arrangement 500, and when it detects a candidate cell for the active set, it informs the cellular network about the candidate cell and possibly about the quality factor of the candidate cell and about the quality factors of the cells in the active set. When selecting the cells for the active set in the uplink direction, a network element 520 may comprise the whole arrangement 500.

Claims

1. A method (200, 300, 400) for determining a candidate cell for an active set, where
- the quality factor of each cell in the active set is determined (202),
- a quality factor of a test cell is determined (203), and
- the test cell is accepted (205) as a candidate cell for the active set if an acceptance criterion is fulfilled, **characterized** in that the acceptance criterion is selected (201) so that for a certain first quality factor of a test cell and for a certain first set of quality factors, consisting of quality factors of cells in a first active set, the acceptance criterion has the same value as for a certain second quality factor of a test cell and for a certain second set of quality factors, consisting of quality factors of cells in a second active set, when the first quality factor is equal to the second quality factor multiplied with any finite number and the first set of quality factors is the same as a set formed of the quality factors belonging to the second set of quality factors multiplied with the same finite number.

2. A method according to claim 1, **characterized** in that said acceptance criterion involves a function, whose value depends at least on quality factors of first cells in the active set and on certain parameter values, and in that said acceptance criterion procudes a same value for said first quality factor of a test cell, said first set of quality factors and first parameter values as for said second quality factor of a test cell, said second set of quality factors and said first parameter values, said first parameter values being any parameter values.

3. A method (300, 400) according to claim 1, **characterized** in that
- the quality factor of the test cell and the quality factors of the cells in the active set are normalized (301) with a number having a certain relative value compared to the values of the quality factors of the cells in the active set,
- a value for the acceptance criterion is determined (302) using the normalized quality factors of the cells in the active set and the normalized quality factor of the test cell and
- the test cell is accepted (303, 205) as a candidate cell, if the acceptance criterion is fulfilled.

4. A method (300, 400) according to claim 3, **characterized** in that the quality factors are normalized using the largest quality factor of the quality factors of the cells in the active set.

5. A method (300, 400) according to claim 3, **characterized** in that the quality factors are normalized using the smallest quality factor of the quality factors of the cells in the active set.

6. A method (300, 400) according to claim 3, **characterized** in that the quality factors are normalized using the average quality factor of the quality factors of the cells in the active set.

7. A method (400) according to claim 1, **characterized** in that the acceptance criterion is adjusted (402) so that for an active set where all the cells have a certain quality factor the acceptance criterion is that certain quality factor.

8. A method according to claim 1, **characterized** in that the method is executed periodically.

9. A method according to claim 1, **characterized** in that the method is triggered by a certain event.

10. A method according to claim 1, **characterized** in that the candidate cell is added to the active set.

11. A method according to claim 1, **characterized** in that the cell having the worst quality factor in the active set is replaced with the candidate cell.

12. A method for determining a cell to be removed from the active set, where
- the quality factor of each cell in the active set is determined,
- a rejection criterion is evaluated using the cell having the smallest quality factor as a test cell and a temporary set, which contains the cells of the active set except the cell having the smallest quality factor, and
- the test cell is removed from the active set if a rejection criterion is fulfilled, **characterized** in that the rejection criterion is selected so that for a certain first quality factor of a test cell and for a certain first set of quality factors, consisting of quality factors of cells in a first temporary set, the rejection criterion has the same value as for a certain second quality factor of a test cell and for a certain second set of quality factors, consisting of quality factors of cells in a second temporary set, when the first quality factor is equal to the second quality factor multiplied with any finite number and the first set of quality factors is the same as a set formed of the quality factors belonging to the second set of quality factors multiplied with the same finite number.

13. A method according to claim 12, **characterized** in that said rejection criterion involves a function, whose value depends at least on quality factors of first cells in the active set and on certain parameter values, and in that said rejection criterion procudes a same value for said first quality factor of a test cell, said first set of quality factors and first parameter values as for said second quality factor of a test cell, said second set of quality factors and said first parameter values, said first parameter values being any parameter values.

14. An arrangement (500) for determining a candidate cell for an active set comprising

- means (501) for determining a quality factor for a test cell and
- means (502) for determining quality factors for the cells in the active set, **characterized** in that it further comprises
- means (503) for selecting an acceptance criterion so that for a certain first quality factor of a test cell and for a certain first set of quality factors, consisting of quality factors of cells in a first active set, the acceptance criterion has the same value as for a certain second quality factor of a test cell and for a certain second set of quality factors, consisting of quality factors of cells in a second active set, when the first quality factor is equal to the second quality factor multiplied with any finite number and the first set of quality factors is the same as a set formed of the quality factors belonging to the second set of quality factors multiplied with the same finite number and
- means (504) for deciding about the acceptance of the test cell as a candidate cell for the active set using the acceptance criterion.

15. An arrangement according to claim 14, **characterized** in that said acceptance criterion involves a function, whose value depends at least on quality factors of first cells in the active set and on certain parameter values, and in that said acceptance criterion procudes a same value for said first quality factor of a test cell, said first set of quality factors and first parameter values as for said second quality factor of a test cell, said second set of quality factors and said first parameter values, said first parameter values being any parameter values.

16. A mobile station (510) comprising

- means (501) for determining a quality factor for a test cell and
- means (502) for determining quality factors for the cells in the active set, **characterized** in that it further comprises
- means (503) for selecting an acceptance criterion so that for a certain first quality factor of a test cell and for a certain first set of quality factors, consisting of quality

factors of cells in a first active set, the acceptance criterion has the same value as for a certain second quality factor of a test cell and for a certain second set of quality factors, consisting of quality factors of cells in a second active set, when the first quality factor is equal to the second quality factor multiplied with any finite number and the first set of quality factors is the same as a set formed of the quality factors belonging to the second set of quality factors multiplied with the same finite number and

- means (504) for deciding about the acceptance of the test cell as a candidate cell for the active set using the acceptance criterion.

17. A mobile station according to claim 16, **characterized** in that said acceptance criterion involves a function, whose value depends at least on quality factors of first cells in the active set and on certain parameter values, and in that said acceptance criterion procudes a same value for said first quality factor of a test cell, said first set of quality factors and first parameter values as for said second quality factor of a test cell, said second set of quality factors and said first parameter values, said first parameter values being any parameter values.

18. A mobile station according to claim 16, **characterized** in that it is a mobile station of an Universal Mobile Communication System.

19. A network element (520) comprising

- means (501) for determining a quality factor for a test cell and
- means (502) for determining quality factors for the cells in the active set, **characterized** in that it further comprises
- means (503) for selecting an acceptance criterion so that for a certain first quality factor of a test cell and for a certain first set of quality factors, consisting of quality factors of cells in a first active set, the acceptance criterion has the same value as for a certain second quality factor of a test cell and for a certain second set of quality factors, consisting of quality factors of cells in a second active set, when the first quality factor is equal to the second quality factor multiplied with any finite number and the first set of quality factors is the same as a set formed of the quality factors belonging to the second set of quality factors multiplied with the same finite number and
- means (504) for deciding about the acceptance of the test cell as a candidate cell for the active set using the acceptance criterion.

20. A network element according to claim 19, **characterized** in that it is a network element of the radio access network of the Universal Mobile Communication System.

21. A network element according to claim 20, **characterized** in that it is a Radio Network Controller.

22. A network element according to claim 19, **characterized** in that said acceptance criterion involves a function, whose value depends at least on quality factors of first cells in the active set and on certain parameter values, and in that said acceptance criterion procudes a same value for said first quality factor of a test cell, said first set of quality factors and first parameter values as for said second quality factor of a test cell, said second set of quality factors and said first parameter values, said first parameter values being any parameter values.

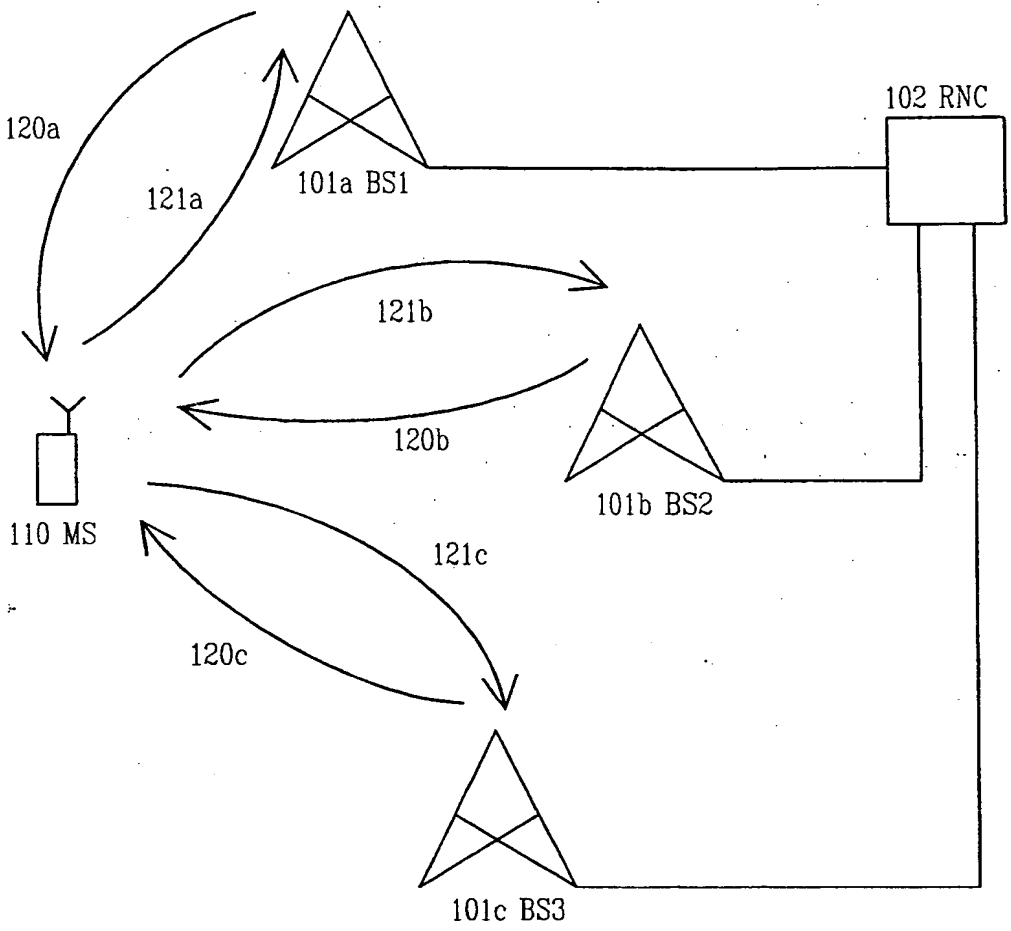

FIG. 1 PRIOR ART

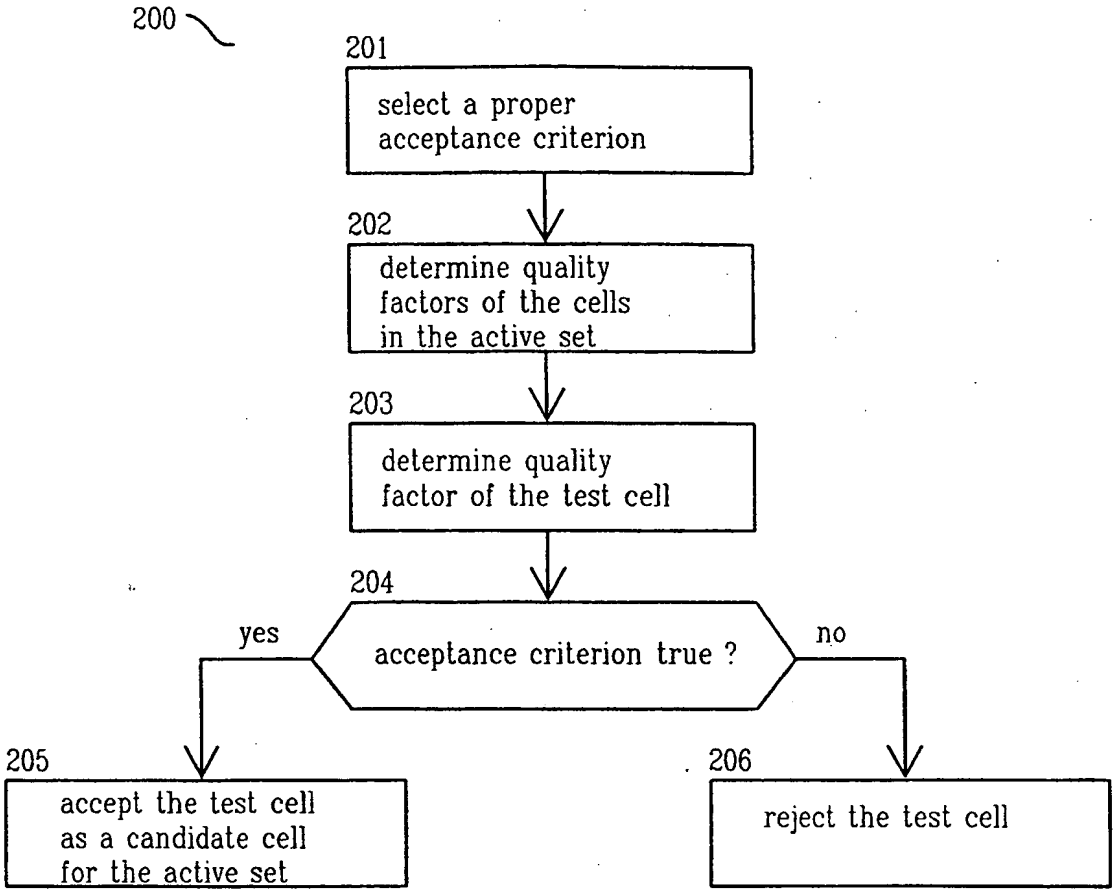
200
201
select a proper acceptance criterion
202
determine quality factors of the cells in the active set
203
determine quality factor of the test cell
204
acceptance criterion true ?
yes
no
205
accept the test cell as a candidate cell for the active set
206
reject the test cell

FIG. 2

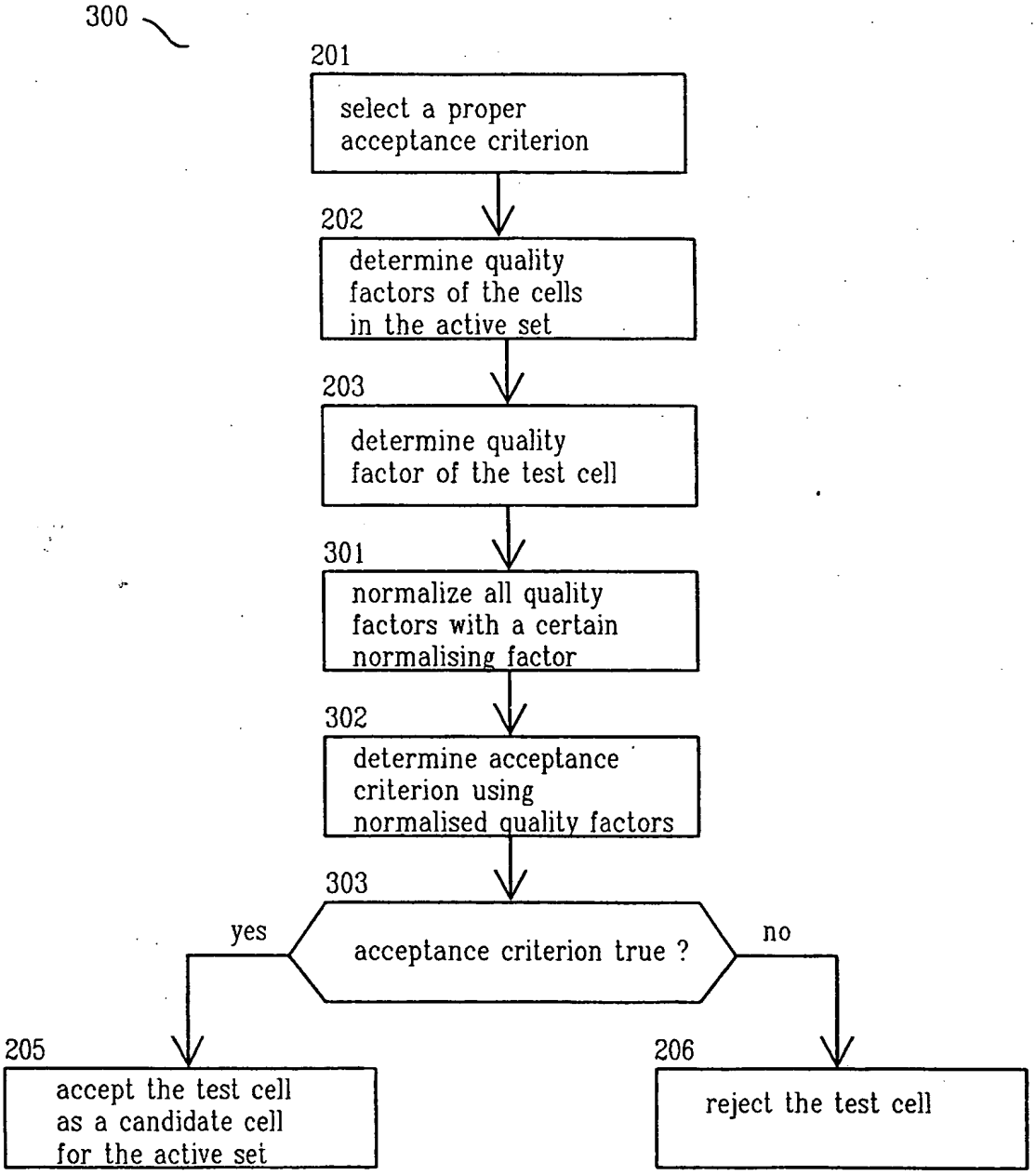
300
201
select a proper acceptance criterion
202
determine quality factors of the cells in the active set
203
determine quality factor of the test cell
301
normalize all quality factors with a certain normalising factor
302
determine acceptance criterion using normalised quality factors
303
acceptance criterion true ?
yes
no
205
accept the test cell as a candidate cell for the active set
206
reject the test cell

FIG. 3

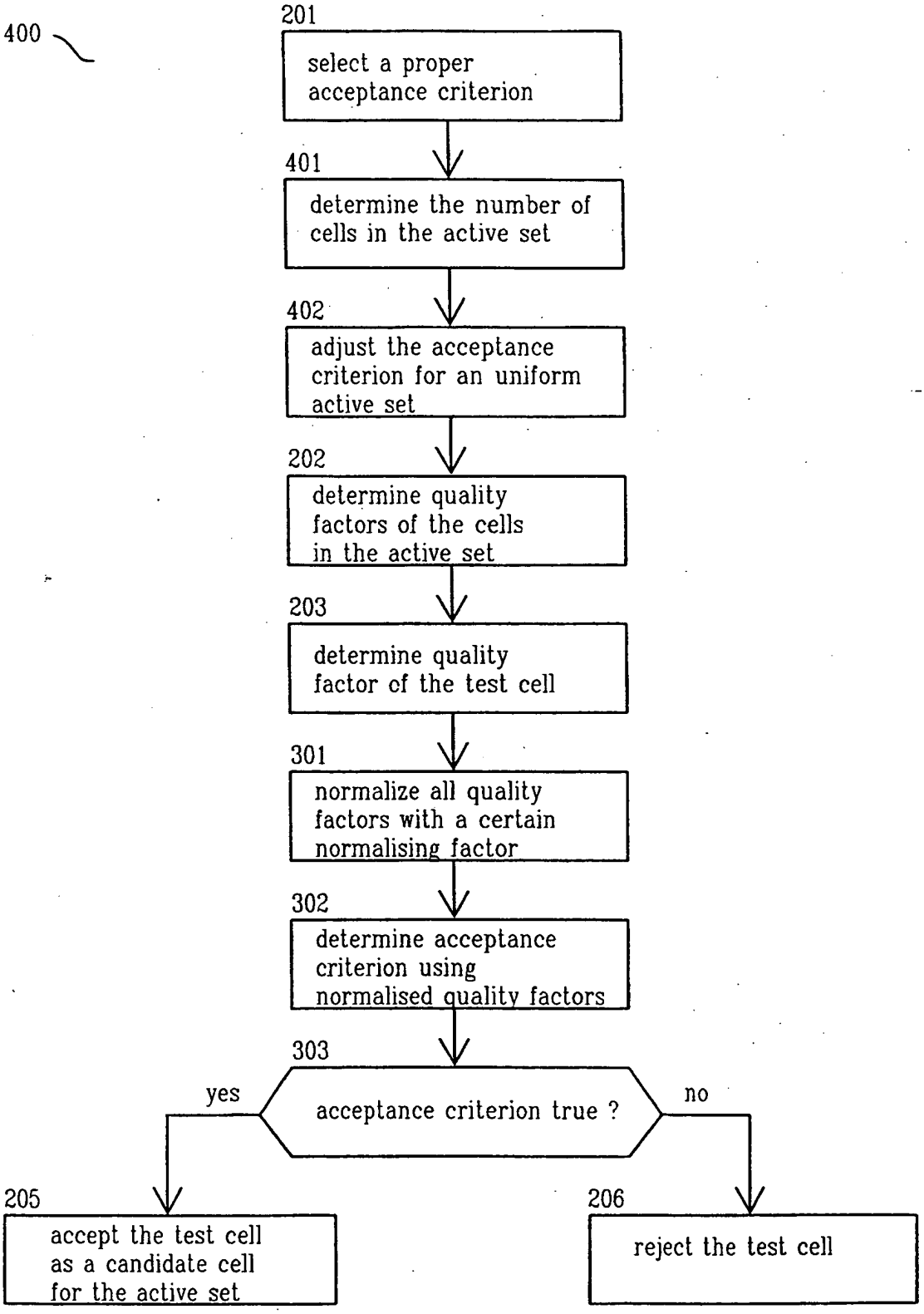
400
201
select a proper acceptance criterion
401
determine the number of cells in the active set
402
adjust the acceptance criterion for an uniform active set
202
determine quality factors of the cells in the active set
203
determine quality factor of the test cell
301
normalize all quality factors with a certain normalising factor
302
determine acceptance criterion using normalised quality factors
303
acceptance criterion true ?
yes
no
205
accept the test cell as a candidate cell for the active set
206
reject the test cell

FIG. 4

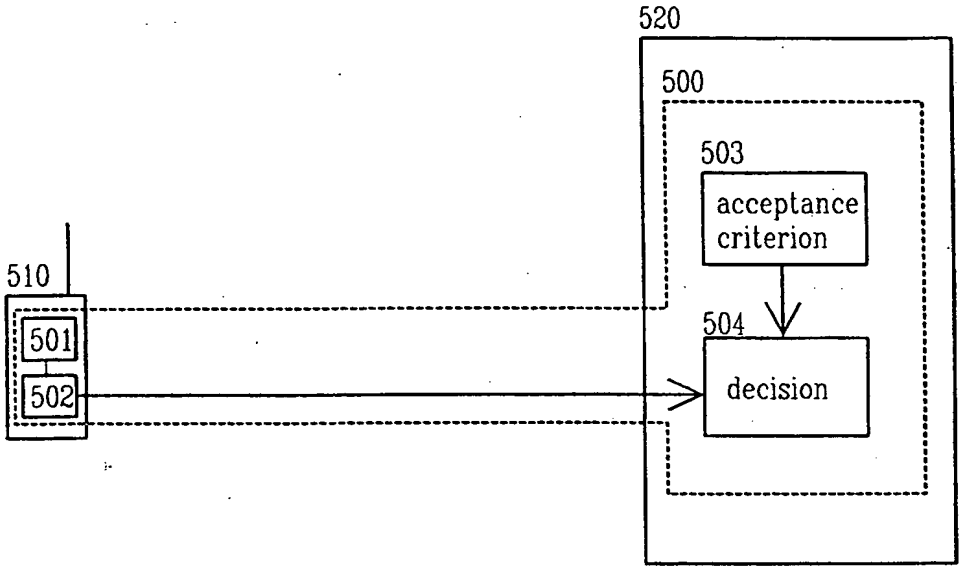

FIG. 5

INTERNATIONAL SEARCH REPORT

Internat... application No.
PCT/FI 00/00796

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: H04Q 7/38
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: H04Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 9904593 A1 (QUALCOMM INCORPORATED), 28 January 1999 (28.01.99), page 4, line 1 - page 6, line 2 --	1,2,7-11, 14-22
Y	WO 9210914 A1 (TELEFONAKTIEBOLAGET LM ERICSSON), 25 June 1992 (25.06.92), figure 1e, abstract --	1,2,7-11, 14-22
Y	WO 9856203 A2 (NOKIA TELECOMMUNICATIONS OY), 10 December 1998 (10.12.98), page 3, line 1 - page 4, line 18 --	1,2,7-11, 14-22

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
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"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
21 December 2000	08-01-2001
Name and mailing address of the ISA Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Stefan Hansson/js Telephone No. +46 8 782 25 00

Form PCT/ISA/210 (second sheet) (July 1998)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI 00/00796

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5577022 A (PADOVANI ET AL), 19 November 1996 (19.11.96), abstract ---	1-22
A	WO 9920072 A1 (INTERDIGITAL TECHNOLOGY CORPORATION), 22 April 1999 (22.04.99), abstract --- --------	1-22

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Information on patent family members

04/12/00

International application No.
PCT/FI 00/00796

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		US 6122511 A	19/09/00

PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference BP100152	FOR FURTHER ACTION	see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.
International application No. PCT/FI 00/00796	International filing date *(day/month/year)* 20 Sept 2000	(Earliest) Priority Date *(day/month/year)* 20 Sept 1999
Applicant Nokia Networks Oy et al		

This international search report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This international search report consists of a total of 3 sheets.

[x] It is also accompanied by a copy of each prior art document cited in this report.

1. **Basis of the report**

   a. With regard to the **language**, the international search was carried out on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.

   [ ] the international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).

   b. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international search was carried out on the basis of the sequence listing:

   [ ] contained in the international application in written form.

   [ ] filed together with the international application in computer readable form.

   [ ] furnished subsequently to this Authority in written form.

   [ ] furnished subsequently to this Authority in computer readable form.

   [ ] the statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

   [ ] the statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

2. [ ] **Certain claims were found unsearchable** (See Box I).

3. [ ] **Unity of invention is lacking** (See Box II).

4. With regard to the **title**,

   [x] the text is approved as submitted by the applicant.

   [ ] the text has been established by this Authority to read as follows:

5. With regard to the **abstract**,

   [x] the text is approved as submitted by the applicant.

   [ ] the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. The figure of the **drawings** to be published with the abstract is Figure No. 2

   [x] as suggested by the applicant.

   [ ] because the applicant failed to suggest a figure.

   [ ] because this figure better characterizes the invention.

   [ ] None of the figures.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI 00/00796

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: H04Q 7/38
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: H04Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 9904593 A1 (QUALCOMM INCORPORATED), 28 January 1999 (28.01.99), page 4, line 1 - page 6, line 2	1,2,7-11, 14-22
Y	WO 9210914 A1 (TELEFONAKTIEBOLAGET LM ERICSSON), 25 June 1992 (25.06.92), figure 1e, abstract	1,2,7-11, 14-22
Y	WO 9856203 A2 (NOKIA TELECOMMUNICATIONS OY), 10 December 1998 (10.12.98), page 3, line 1 - page 4, line 18	1,2,7-11, 14-22

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

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"A" document defining the general state of the art which is not considered to be of particular relevance
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"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
21 December 2000	08-01-2001
Name and mailing address of the ISA Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Stefan Hansson/js Telephone No. +46 8 782 25 00

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI 00/00796

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5577022 A (PADOVANI ET AL), 19 November 1996 (19.11.96), abstract ---	1-22
A	WO 9920072 A1 (INTERDIGITAL TECHNOLOGY CORPORATION), 22 April 1999 (22.04.99), abstract --- --------	1-22

INTERNATIONAL SEARCH REPORT
Information on patent family members

04/12/00

International application No.
PCT/FI 00/00796

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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		BR 9812268 A	18/07/00
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		EP 1005772 A	07/06/00
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		NO 20000259 A	19/01/00
		US 6055428 A	25/04/00
		ZA 9806450 A	02/02/99
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Search Report

PATENTTI- JA REKISTERIHALLITUS **TUTKIMUSRAPORTTI**
Patentti- ja innovaatiolinja Patent & Innovation

PATENTTIHAKEMUS NRO Appln. No.	LUOKITUS classification
19992005	H04Q 7/38

TUTKITTU AINEISTO Research material

Patenttijulkaisukokoelma (FI, SE, NO, DK, DE, CH, EP, WO, GB, US), tutkitut luokat
Published pat. specific. Searched classes

Tiedonhaut ja muu aineisto Data search and other material

Haku Epodoc ja WPI tietokannoissa termeillä: active set, candidate (cell or set)
Search in EPODOC & WPI

VIITEJULKAISUT

Kategoria*) Category	Julkaisun tunnistetiedot Identification data	Koskee vaatimuksia Relev. to claims
A	WO 99/04593 lk H04Q 7/38, Qualcomm Incorporated	

*) X Patentoitavuuden kannalta merkittävä julkaisu yksinään tarkasteltuna
Y Patentoitavuuden kannalta merkittävä julkaisu. kun otetaan huomioon tämä ja yksi tai useampi samaan kategoriaan kuuluva julkaisu
A Yleistä tekniikan tasoa edustava julkaisu, ei kuitenkaan patentoitavuuden este

A. Technological background of a novelty bar

Päiväys Date	Tutkija Examiner
14.8.2000	J. Saranka

PCT REQUEST BP100152

Original (for **SUBMISSION**) - printed on 20.09.2000 08:33:10 AM

0 **0-1**	**For receiving Office use only** International Application No.	
0-2	International Filing Date	
0-3	Name of receiving Office and "PCT International Application"	
0-4 0-4-1	**Form - PCT/RO/101 PCT Request** Prepared using	PCT-EASY Version 2.91 (updated 01.07.2000)
0-5	Petition The undersigned requests that the present international application be processed according to the Patent Cooperation Treaty	
0-6	**Receiving Office (specified by the applicant)**	National Board of Patents and Registration (Finland) (RO/FI)
0-7	**Applicant's or agent's file reference**	BP100152
I	Title of invention	METHOD FOR DETERMINING A CANDIDATE FOR AN ACTIVE SET
II II-1 II-2 II-4 II-5 II-6 II-7 II-8 II-9	Applicant This person is: Applicant for Name Address: State of nationality State of residence Telephone No. Facsimile No.	applicant only all designated States except US NOKIA NETWORKS OY P.O. Box 300 FIN-00045 Nokia Group Finland FI FI +358-9-51121 +358-9-51168080
III-1 III-1-1 III-1-2 III-1-4 III-1-5 III-1-6 III-1-7	Applicant and/or inventor This person is: Applicant for Name (LAST, First) Address: State of nationality State of residence	applicant and inventor US only SALONAHO, Oscar Oksasenkatu 4bA 8 FIN-00100 Helsinki Finland FI FI

PCT REQUEST BP100152

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IV-1	Agent **or common representative; or address for correspondence** The person identified below is hereby/has been appointed to act on behalf of the applicant(s) before the competent International Authorities as:	agent
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V	**Designation of States**	
V-1	Regional Patent (other kinds of protection or treatment, if any, are specified between parentheses after the designation(s) concerned)	AP: GH GM KE LS MW MZ SD SL SZ TZ UG ZW and any other State which is a Contracting State of the Harare Protocol and of the PCT EA: AM AZ BY KG KZ MD RU TJ TM and any other State which is a Contracting State of the Eurasian Patent Convention and of the PCT EP: AT BE CH&LI CY DE DK ES FI FR GB GR IE IT LU MC NL PT SE and any other State which is a Contracting State of the European Patent Convention and of the PCT OA: BF BJ CF CG CI CM GA GN GW ML MR NE SN TD TG and any other State which is a member State of OAPI and a Contracting State of the PCT
V-2	National Patent (other kinds of protection or treatment, if any, are specified between parentheses after the designation(s) concerned)	AE AG AL AM AT AU AZ BA BB BG BR BY BZ CA CH&LI CN CR CU CZ DE DK DM DZ EE ES FI GB GD GE GH GM HR HU ID IL IN IS JP KE KG KP KR KZ LC LK LR LS LT LU LV MA MD MG MK MN MW MX MZ NO NZ PL PT RO RU SD SE SG SI SK SL TJ TM TR TT TZ UA UG US UZ VN YU ZA ZW
V-5	*Precautionary* **Designation Statement** In addition to the designations made under items V-1, V-2 and V-3, the applicant also makes under Rule 4.9(b) all designations which would be permitted under the PCT except any designation(s) of the State(s) indicated under item V-6 below. The applicant declares that those additional designations are subject to confirmation and that any designation which is not confirmed before the expiration of 15 months from the priority date is to be regarded as withdrawn by the applicant at the expiration of that time limit.	
V-6	Exclusion(s) **from precautionary designations**	NONE

PCT REQUEST BP100152

Original (for **SUBMISSION**) - printed on 20.09.2000 08:33:10 AM

VI-1	Priority claim of earlier national application		
VI-1-1	Filing date	20 September 1999 (20.09.1999)	
VI-1-2	Number	19992005	
VI-1-3	Country	FI	
VI-2	Priority document request The receiving Office is requested to prepare and transmit to the International Bureau a certified copy of the earlier application(s) identified above as item(s):	VI-1	
VII-1	International Searching Authority Chosen	Swedish Patent Office (ISA/SE)	
VIII	Check list	number of sheets	electronic file(s) attached
VIII-1	Request	4	-
VIII-2	Description	13	-
VIII-3	Claims	5	-
VIII-4	Abstract	1	bp100152.txt
VIII-5	Drawings	5	-
VIII-7	TOTAL	28	
	Accompanying items	paper document(s) attached	electronic file(s) attached
VIII-8	Fee calculation sheet	✓	-
VIII-9	Separate signed power of attorney	✓	-
VIII-10	Copy of general power of attorney	✓	-
VIII-16	PCT-EASY diskette	-	diskette
VIII-17	Other (specified):	Copy fo Official Action in FI 19992005	-
VIII-18	Figure of the drawings which should accompany the abstract	2	
VIII-19	Language of filing of the international application	English	
IX-1	Signature of applicant or agent		
IX-1-1	Name	BERGGREN OY AB	
IX-1-2	Name of signatory	Sirpa Kuisma	
IX-1-3	Capacity	Patent Attorney	

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10-1	Date of actual receipt of the purported international application	
10-2	Drawings:	
10-2-1	Received	
10-2-2	Not received	
10-3	Corrected date of actual receipt due to later but timely received papers or drawings completing the purported international application	
10-4	Date of timely receipt of the required corrections under PCT Article 11(2)	
10-5	International Searching Authority	ISA/SE

PCT REQUEST

BP100152

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10-6	Transmittal of search copy delayed until search fee is paid	

FOR INTERNATIONAL BUREAU USE ONLY

11-1	Date of receipt of the record copy by the International Bureau	

PCT (ANNEX - FEE CALCULATION SHEET)

BP100152

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(This sheet is not part of and does not count as a sheet of the international application)

0 0-1	For receiving Office use only International Application No.	
0-2	Date stamp of the receiving Office	

0-4 0-4-1	Form - PCT/RO/101 (Annex) PCT Fee Calculation Sheet Prepared using		PCT-EASY Version 2.91 (updated 01.07.2000)		
0-9	Applicant's or agent's file reference		BP100152		
2	Applicant		NOKIA NETWORKS OY, et al.		
12	Calculation of prescribed fees		fee amount/multiplier	total amounts (FIM)	
12-1	Transmittal fee	T	⇨	800	
12-2	Search fee	S	⇨	5 618.71	
12-3	International fee Basic fee (first 30 sheets)	b1	2 431.8		
12-4	Remaining sheets		0		
12-5	Additional amount	(X)	53.51		
12-6	Total additional amount	b2	0		
12-7	b1 + b2 =	B	2 431.8		
12-8	Designation fees Number of designations contained in international application		87		
12-9	Number of designation fees payable (maximum 8)		8		
12-10	Amount of designation fee	(X)	523.22		
12-11	Total designation fees	D	4 185.76		
12-12	PCT-EASY fee reduction	R	-749.16		
12-13	Total international fee (B+D-R)	I	⇨	5 868.4	
12-14	Fee for priority document Number of priority documents requested		1		
12-15	Fee per document	(X)	422		
12-16	Total priority document fee	P	⇨	422	
12-17	TOTAL FEES PAYABLE (T+S+I+P)		⇨	12 709.11	
12-19	Mode of payment		cheque		

VALIDATION LOG AND REMARKS

13-2-6	Validation messages Contents	Green? Reference number for attached copy of general power of attorney not indicated.
13-2-7	Validation messages Fees	Green? Please verify that modified fee amounts are correct.

Berggren
PATENTTITOIMISTO • PATENT & TRADEMARK ATTORNEYS

10/088314
JC10 Rec'd PCT/PTO 13 MAR 2002

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6 November 2001

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Our Ref.: BP100152/SKU/MM

REPLY TO WRITTEN OPINION
INTERNATIONAL PATENT APPLICATION NO. PCT/FI00/00796
APPLICANT: NOKIA NETWORKS OY

In response to the Written Opinion the claims are amended and the following is respectfully presented.

The enclosed independent claims are amended to specify that the acceptance/rejection criterion defines a value for a limit (i.e. a threshold) for accepting/rejecting a test cell. Support for this amendment is found in the description e.g. on page 3, lines 11 and 16-17.

The wording of the characterizing part of an independent claim is further clarified to reflect the fact that the acceptance/rejection criterion is such that the limit (or threshold) value depends on the relative value of the quality factor of the test cell with respect to the quality factors in the active/temporary set. Support for this modification is found in the description for example on page 7, lines 17-20.

The two-part form of the independent claims reflects the prior art, and the characterizing portion defines the invention.

Various acceptance/rejection criteria have been suggested; the present application, for example, refers to CDMA2000 RTT standard and document D1 refers to IS-95 A standard. The criteria disclosed in these standards are clearly different from the one specified in the independent claims, although CDMA2000 RTT standard does appreciate a criterion dependent on the quality of all the cells in the active set.

Applicant therefore respectfully argues that the Examiner simplifies the problem of selecting a proper criteria, which on one hand minimizes the number of required base stations transmitting redundant information and on the

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other hand guarantees the quality of the connection for a mobile station. The fact that various standards have suggested other criteria supports the applicant's view that the criteria in specified in the characterizing portion of the independent claims is inventive.

A reconsideration of the statement regarding the inventive step in the Written Opinion is therefore respectfully requested.

It is not straightforward to combine claims 1 and 12 into a single independent method claim, as in claim 1 the test cell is one of the cells in the active set and in claim 12 it is not. Furthermore, as the opening parts of the claims 1 and 12 clearly describe the methods specified in the claims, the applicant wishes to retain the two method claims.

Claim 16 relates to a mobile station and Claim 19 to a network element. Applicant is of the opinion that it is not evident that term "network element" covers a mobile station, and therefore wishes to retain both independent device claims.

Claim 14 defines an arrangement, which may be implemented partly in a network element and partly in a mobile station. The scope of protection is thus different from those provided by either claim 16 or claim 19.

The reference signs 111a, 111b and 111c have been removed from the description on page 2, line 4. The description is brought into conformity with the amended claims (replacement pages 4-6 and 6a). An evident mistake is further corrected on replacement page 7, line 6; support for the correction are all other references to the scalar a or to a/the finite number in the description and claims.

No other amendments than the ones specified above have been made to the description.

Should the Examiner have any concerns with the present application, a further opportunity to submit amendments or arguments (Rule 66.4(b) PCT) is kindly requested to be given to the Applicant, preferably in the form of a further Written Opinion.

BERGGREN OY AB

Sirpa Kuisma
Patent Attorney

Encl. replacement pages 2, 4-6, 6a, 7, 14-18

Figure 1 presents a schematic drawing of a cellular network which comprises base stations 101a, 101b and 101c. In Figure 1, these base stations are all connected to a single radio network controller 102 and each base station is in the middle of a cell. Figure 1 presents one mobile station 110. The base stations transmit downlink data to mobile stations (arrows 120a, 120b and 120c) and receive uplink data from mobile stations (arrows 121a, 121b and 121c).

In general a base station may comprise many transmitters, each of which transmit a separate radio signal. In systems employing CDMA methods, the transmitters may use different spreading codes. Here term cell is used to refer either to a base station or, if a base station comprises many transmitters, to a transmitter. In a situation where a mobile station receives good quality downlink transmissions from many cells, it has to be decided which cell a certain mobile station communicates with.

Usually the cellular network informs the mobile station of the possible cells, for example, selected based on the location of the mobile station. The information about the nearest cells is called neighbor list. In a cellular network which employs CDMA methods, the neighbor list may comprise the downlink spreading codes of the cells. By taking the spreading codes listed in the neighbor list into use, the mobile station may separate the data flows sent to it from each cell from the radio signal it receives. The neighbor list of the mobile station 110 may comprise, for example, the cells corresponding to base stations 101a, 101b and 101c, assuming that a base station corresponds to one cell.

Usually a pilot signal is transmitted in each cell. This pilot signal carries no changing data, so it can be quite straightforwardly used in estimating the quality of the downlink radio transmission of a certain cell. A mobile station may, for example, estimate the quality of the radio transmission of all the cells in the neighbor list. A suitable parameter for quality estimation is, for example in a cellular system employing CDMA methods, the E_C/I_0 ratio, where E_C is energy per chip and I_0 is the interference. Any other parameter measuring the quality of the signal may also be used.

The cells with which a mobile station communicates form the active set of that mobile station. A radio network controller, for example, directs the downlink data heading to a certain mobile station, to all the cells in the active set. Correspondingly, the mobile station listens to the downlink transmissions of all the cells in the active set. For example, the cells corresponding to base stations 101a and 101b can form the active set of the mobile station 110.

In the second example the active set contains also two cells, and now the quality factors are $P_1 = 3$ and $P_2 = 3$. The acceptance limit in this example is $Q = 9.5$ dB. The quality factors of the cells in the active set are 5 dB, so a cell has to have a quality factor 4.5 dB higher than the cells in the active set to be accepted to the active set. Correspondingly, expressed in absolute values, a cell should have a quality factor $P_C = 9.5$ to be accepted to the active set. Intuitively, the acceptance criterion should also in this second example produce the result that a test cell can be accepted to the active set if the quality factor of the cell is larger than 3.

The current acceptance criterion thus leads to situation where intuitively similar situations produce a different acceptance decision. A further problem with the acceptance criterion is that for an active set whose cells have the same quality factors, from here on called an uniform active set, the acceptance limit is not equal to the quality factor.

The object of the invention is to present a method for determining a candidate cell for the active set. A further object of the invention is to present a method where similar active sets and test cells produce the same acceptance decision. Further, it is advantageous that the method for determining a candidate cell accepts a cell whose quality factor is equal to the quality factor of an uniform active set.

The object of the invention is achieved by selecting the acceptance criterion so that it is indifferent to the absolute values of the quality factors.

A method according to the invention is a method for determining a candidate cell for an active set, where
- the quality factor of each cell in the active set is determined,
- a quality factor of a test cell is determined, and
- the test cell is accepted as a candidate cell for the active set, if an acceptance criterion, which defines a value for a limit for accepting a test cell, is fulfilled,

and the method is characterized in that such an acceptance criterion is selected that a first limit value is equal to a second limit value multiplied with a finite number, wherein said first limit value is for a certain first quality factor of a test cell and for a certain first set of quality factors, consisting of quality factors of cells in a first active set, said second limit value is for a certain second quality factor of a test cell and for a certain second set of quality factors, consisting of quality factors of cells in a second active set, and the first quality factor is equal to the second quality factor multiplied with the same finite number and the first set of quality factors is the same

as a set formed of the quality factors belonging to the second set of quality factors multiplied with the same finite number.

A method according to the invention is a method for determining a cell to be removed from the active set, where

- the quality factor of each cell in the active set is determined,
- a rejection criterion is evaluated using the cell having the smallest quality factor as a test cell and a temporary set, which contains the cells of the active set except the cell having the smallest quality factor, and
- the test cell is removed from the active set, if a rejection criterion, which defines a value for a limit for rejecting a test cell, is fulfilled,

and it is characterized in that such a rejection criterion is selected that a first limit value is equal to a second limit value multiplied with a finite number, wherein said first limit value is for a certain first quality factor of a test cell and for a certain first set of quality factors, consisting of quality factors of cells in a first temporary set, said second limit value is for a certain second quality factor of a test cell and for a certain second set of quality factors, consisting of quality factors of cells in a second temporary set, and the first quality factor is equal to the second quality factor multiplied with the same finite number and the first set of quality factors is the same as a set formed of the quality factors belonging to the second set of quality factors multiplied with the same finite number.

The invention relates also to an arrangement for determining a candidate cell for an active set comprising

- means for determining a quality factor for a test cell and
- means for determining quality factors for the cells in the active set, which arrangement is characterized in that it further comprises
- means for selecting such an acceptance criterion, which defines a value for a limit for accepting a test cell, that a first limit value is equal to a second limit value multiplied with a finite number, wherein said first limit value is for a certain first quality factor of a test cell and for a certain first set of quality factors, consisting of quality factors of cells in a first active set, the second limit value is for a certain second quality factor of a test cell and for a certain second set of quality factors, consisting of quality factors of cells in a second active set, and the first quality factor is equal to the second quality factor multiplied with the same finite number and the first set of quality factors is the same as a set formed of the quality factors belonging to the second set of quality factors multiplied with the same finite number and

- means for deciding about the acceptance of the test cell as a candidate cell for the active set using the acceptance criterion.

A mobile station according to the invention comprises
- means for determining a quality factor for a test cell and
- means for determining quality factors for the cells in the active set, and it is characterized in that it further comprises
- means for selecting such an acceptance criterion, which defines a limit for accepting a test cell, that a first limit value is equal to a second limit value multiplied with a finite number, wherein said first limit value is for a certain first quality factor of a test cell and for a certain first set of quality factors, consisting of quality factors of cells in a first active set, the second limit value is for a certain second quality factor of a test cell and for a certain second set of quality factors, consisting of quality factors of cells in a second active set, and the first quality factor is equal to the second quality factor multiplied with the same finite number and the first set of quality factors is the same as a set formed of the quality factors belonging to the second set of quality factors multiplied with the same finite number and
- means for deciding about the acceptance of the test cell as a candidate cell for the active set using the acceptance criterion.

The invention relates to a network element comprising
- means for determining a quality factor for a test cell and
- means for determining quality factors for the cells in the active set, which network element is characterized in that it further comprises
- means for selecting such an acceptance criterion, which defines a value for a limit for accepting a test cell, that a first limit value is equal to a second limit value multiplied with a finite number, wherein said first limit value is for a certain first quality factor of a test cell and for a certain first set of quality factors, consisting of quality factors of cells in a first active set, said second limit value is for a certain second quality factor of a test cell and for a certain second set of quality factors, consisting of quality factors of cells in a second active set, and the first quality factor is equal to the second quality factor multiplied with the same finite number and the first set of quality factors is the same as a set formed of the quality factors belonging to the second set of quality factors multiplied with the same finite number and
- means for deciding about the acceptance of the test cell as a candidate cell for the active set using the acceptance criterion.

In a method according to the invention, the quality factors of the cells in the active set are determined. Further, the quality factor of a test cell not in the active set but, for example, in the neighbor list is determined. The choice of the quality factors used in a method according to the invention is not restricted. The term accepting a test cell as a candidate cell for the active cell refers to a situation, where a mobile station or the cellular network notices that a certain cell has good enough quality factor, for example, to be added to the active set. The acceptance of a test cell as a candidate cell may trigger, for example, the transmission of the transmission quality reports from a mobile station to the cellular network. Thereafter the cellular network may decide whether the active set is modified.

In the method according to the invention, the acceptance criterion is selected so that it fulfills the following condition. The acceptance criterion Q' for a test cell having a quality factor P_T and for an active set having n cells, whose quality factors are P_1, P_2, ..., P_n, is $Q'(P_T, P_1, P_2, P_3, \ldots)$. The value $Q'(P_T, P_1, P_2, P_3, \ldots)$ is equal to the value of acceptance criterion for a test cell having a quality factor aP_T and for an active set having n cells, whose quality factors are aP_1, aP_2, ..., aP_n. Here a is any finite scalar number. The condition for the acceptance criterion can be written as

$$\forall a \quad Q'(aP_T, aP_1, aP_2, aP_3, \ldots) = Q'(P_T, P_1, P_2, P_3, \ldots).$$

The quality factor of the test cell and the quality factors of cells in the active set are not restricted, the condition holds for any values of P_T and P_i, where P_i is the quality factor of cell i in the active set. An example of a acceptance criterion fulfilling the condition is the following criterion where geometric mean is employed

$$Q'(P_T, P_1, P_2, \ldots): \quad P_T > \sqrt[n]{\prod P_i}$$

because $Q'(aP_T, aP_1, aP_2, aP_3, \ldots)$ is

$$Q'(aP_T, aP_1, aP_2, \ldots): \quad aP_T > \sqrt[n]{\prod aP_i} = \sqrt[n]{a^n}\sqrt[n]{\prod P_i} = a\sqrt[n]{\prod P_i}.$$

If for a certain value of P_T, $Q'(P_T, P_1, P_2, P_3, \ldots)$ is true, then $Q'(aP_T, aP_1, aP_2, aP_3, \ldots)$ is also true. In other words, if a test cell having quality factor P_T is accepted as a candidate cell for the active set whose cells have quality factors P_1 and P_2, a test cell having quality factor aP_T is accepted as a candidate cell for the active set whose cells have quality factors aP_1 and aP_2. It is possible to use only some of the quality factors of the cells in the active set in the acceptance criterion, but typically the quality factors of all cells in the active set are used.

In one embodiment of the invention said acceptance criterion involves a function, whose value depends at least on quality factors of first cells in the active set and on certain parameter values. Said acceptance criterion procudes a same value for said first quality factor of a test cell, said first set of quality factors and first parameter values as for said second quality factor of a test cell, said second set of quality factors and the same first parameter values, said first parameter values being any parameter values.

It may, however, be easier to normalized all the quality factors with a certain number and then use the normalized quality factors. The acceptance decision may, for example, be a function having the normalized quality factors as variables. The

Claims

1. A method (200, 300, 400) for determining a candidate cell for an active set, where
- the quality factor of each cell in the active set is determined (202),
- a quality factor of a test cell is determined (203), and
- the test cell is accepted (205) as a candidate cell for the active set, if an acceptance criterion, which defines a value for a limit for accepting a test cell, is fulfilled, **characterized** in that such an acceptance criterion is selected (201) that a first limit value is equal to a second limit value multiplied with a finite number, wherein said first limit value is for a certain first quality factor of a test cell and for a certain first set of quality factors, consisting of quality factors of cells in a first active set, said second limit value is for a certain second quality factor of a test cell and for a certain second set of quality factors, consisting of quality factors of cells in a second active set, and the first quality factor is equal to the second quality factor multiplied with the same finite number and the first set of quality factors is the same as a set formed of the quality factors belonging to the second set of quality factors multiplied with the same finite number.

2. A method according to claim 1, **characterized** in that said acceptance criterion involves a function, whose value depends at least on quality factors of first cells in the active set and on certain parameter values, and in that said acceptance criterion produces a first limit value for said first quality factor of a test cell, said first set of quality factors and first parameter values, which first limit value is equal to a second limit value multiplied with the finite number, said second limit value being for said second quality factor of a test cell, said second set of quality factors and said first parameter values, said first parameter values being any parameter values.

3. A method (300, 400) according to claim 1, **characterized** in that
- the quality factor of the test cell and the quality factors of the cells in the active set are normalized (301) with a number having a predefined relative value compared to the values of the quality factors of the cells in the active set,
- a value for the limit is determined (302) using the normalized quality factors of the cells in the active set and the normalized quality factor of the test cell and
- the test cell is accepted (303, 205) as a candidate cell, if the acceptance criterion is fulfilled.

4. A method (300, 400) according to claim 3, **characterized** in that the quality factors are normalized using the largest quality factor of the quality factors of the cells in the active set.

5. A method (300, 400) according to claim 3, **characterized** in that the quality factors are normalized using the smallest quality factor of the quality factors of the cells in the active set.

6. A method (300, 400) according to claim 3, **characterized** in that the quality factors are normalized using the average quality factor of the quality factors of the cells in the active set.

7. A method (400) according to claim 1, **characterized** in that the acceptance criterion is such that for an active set where all the cells have a certain quality factor the limit is that certain quality factor.

8. A method according to claim 1, **characterized** in that the method is executed periodically.

9. A method according to claim 1, **characterized** in that the method is triggered by a certain event.

10. A method according to claim 1, **characterized** in that the candidate cell is added to the active set.

11. A method according to claim 1, **characterized** in that the cell having the worst quality factor in the active set is replaced with the candidate cell.

12. A method for determining a cell to be removed from the active set, where
- the quality factor of each cell in the active set is determined,
- a rejection criterion is evaluated using the cell having the smallest quality factor as a test cell and a temporary set, which contains the cells of the active set except the cell having the smallest quality factor, and
- the test cell is removed from the active set, if a rejection criterion, which defines a value for a limit for rejecting a test cell, is fulfilled, **characterized** in that such a rejection criterion is selected that a first limit value is equal to a second limit value multiplied with a finite number, wherein said first limit value is for a certain first quality factor of a test cell and for a certain first set of quality factors, consisting of quality factors of cells in a first temporary set, the second limit value is for a certain second quality factor of a test cell and for a certain second set of quality factors,

consisting of quality factors of cells in a second temporary set, and the first quality factor is equal to the second quality factor multiplied with the same finite number and the first set of quality factors is the same as a set formed of the quality factors belonging to the second set of quality factors multiplied with the same finite number.

13. A method according to claim 12, **characterized** in that said rejection criterion involves a function, whose value depends at least on quality factors of first cells in the temporary set and on certain parameter values, and in that said rejection criterion produces a first limit value for said first quality factor of a test cell, said first set of quality factors and first parameter values, which first limit value is equal to a second limit value multiplied with the same finite number, the second limit value being for said second quality factor of a test cell, said second set of quality factors and said first parameter values, said first parameter values being any parameter values.

14. An arrangement (500) for determining a candidate cell for an active set comprising

- means (501) for determining a quality factor for a test cell and
- means (502) for determining quality factors for the cells in the active set, **characterized** in that it further comprises
- means (503) for selecting such an acceptance criterion, which defines a value for a limit for accepting a test cell, that a first limit value is equal to a second limit value multiplied with a finite number, wherein said first limit value is for a certain first quality factor of a test cell and for a certain first set of quality factors, consisting of quality factors of cells in a first active set, the second limit value is for a certain second quality factor of a test cell and for a certain second set of quality factors, consisting of quality factors of cells in a second active set, and the first quality factor is equal to the second quality factor multiplied with the same finite number and the first set of quality factors is the same as a set formed of the quality factors belonging to the second set of quality factors multiplied with the same finite number and
- means (504) for deciding about the acceptance of the test cell as a candidate cell for the active set using the acceptance criterion.

15. An arrangement according to claim 14, **characterized** in that said acceptance criterion involves a function, whose value depends at least on quality factors of first cells in the active set and on certain parameter values, and in that said acceptance criterion produces a first limit value for said first quality factor of a test cell, said first set of quality factors and first parameter values, which first limit value is equal

to a second limit value multiplied with the finite number, the second limit value being for said second quality factor of a test cell, said second set of quality factors and said first parameter values, said first parameter values being any parameter values.

16. A mobile station (510) comprising
- means (501) for determining a quality factor for a test cell and
- means (502) for determining quality factors for the cells in the active set, **characterized** in that it further comprises
- means (503) for selecting such an acceptance criterion, which defines a limit for accepting a test cell, that a first limit value is equal to a second limit value multiplied with a finite number, wherein said first limit value is for a certain first quality factor of a test cell and for a certain first set of quality factors, consisting of quality factors of cells in a first active set, the second limit value is for a certain second quality factor of a test cell and for a certain second set of quality factors, consisting of quality factors of cells in a second active set, and the first quality factor is equal to the second quality factor multiplied with the same finite number and the first set of quality factors is the same as a set formed of the quality factors belonging to the second set of quality factors multiplied with the same finite number and
- means (504) for deciding about the acceptance of the test cell as a candidate cell for the active set using the acceptance criterion.

17. A mobile station according to claim 16, **characterized** in that said acceptance criterion involves a function, whose value depends at least on quality factors of first cells in the active set and on certain parameter values, and in that said acceptance criterion produces a first limit value for said first quality factor of a test cell, said first set of quality factors and first parameter values, which first limit value is equal to a second limit value multiplied with the finite number, the second limit value being for said second quality factor of a test cell, said second set of quality factors and said first parameter values, said first parameter values being any parameter values.

18. A mobile station according to claim 16, **characterized** in that it is a mobile station of an Universal Mobile Communication System.

19. A network element (520) comprising
- means (501) for determining a quality factor for a test cell and

- means (502) for determining quality factors for the cells in the active set, **characterized** in that it further comprises
- means (503) for selecting such an acceptance criterion, which defines a value for a limit for accepting a test cell, that a first limit value is equal to a second limit value multiplied with a finite number, wherein said first limit value is for a certain first quality factor of a test cell and for a certain first set of quality factors, consisting of quality factors of cells in a first active set, said second limit value is for a certain second quality factor of a test cell and for a certain second set of quality factors, consisting of quality factors of cells in a second active set, and the first quality factor is equal to the second quality factor multiplied with the same finite number and the first set of quality factors is the same as a set formed of the quality factors belonging to the second set of quality factors multiplied with the same finite number and
- means (504) for deciding about the acceptance of the test cell as a candidate cell for the active set using the acceptance criterion.

20. A network element according to claim 19, **characterized** in that it is a network element of the radio access network of the Universal Mobile Communication System.

21. A network element according to claim 20, **characterized** in that it is a Radio Network Controller.

22. A network element according to claim 19, **characterized** in that said acceptance criterion involves a function, whose value depends at least on quality factors of first cells in the active set and on certain parameter values, and in that said acceptance criterion produces a first limit value for said first quality factor of a test cell, said first set of quality factors and first parameter values, which first limit value is equal to a second limit value multiplied with the finite number, the second limit value being for said second quality factor of a test cell, said second set of quality factors and said first parameter values, said first parameter values being any parameter values.

PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference	FOR FURTHER ACTION	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
BP100152		
International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/FI00/00796	20/09/2000	20/09/1999
International Patent Classification (IPC) or national classification and IPC H04Q7/38		
Applicant NOKIA NETWORKS OY et al.		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 9 sheets, including this cover sheet.

   ☒ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

   These annexes consist of a total of 11 sheets.

3. This report contains indications relating to the following items:

   - I ☒ Basis of the report
   - II ☐ Priority
   - III ☒ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
   - IV ☐ Lack of unity of invention
   - V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations suporting such statement
   - VI ☐ Certain documents cited
   - VII ☐ Certain defects in the international application
   - VIII ☒ Certain observations on the international application

Date of submission of the demand	Date of completion of this report
18/04/2001	18.12.2001
Name and mailing address of the international preliminary examining authority: European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized officer Oteo Mayayo, C Telephone No. +49 89 2399 7563

Form PCT/IPEA/409 (cover sheet) (January 1994)

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/FI00/00796

I. Basis of the report

1. With regard to the **elements** of the international application *(Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17))*:
Description, pages:

1,3,8-13	as originally filed	
2,4-6,6a,7	with telefax of	06/11/2001

Claims, No.:

1-22	with telefax of	06/11/2001

Drawings, sheets:

1/5-5/5	as originally filed

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

   These elements were available or furnished to this Authority in the following language: , which is:

   - ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
   - ☐ the language of publication of the international application (under Rule 48.3(b)).
   - ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

   - ☐ contained in the international application in written form.
   - ☐ filed together with the international application in computer readable form.
   - ☐ furnished subsequently to this Authority in written form.
   - ☐ furnished subsequently to this Authority in computer readable form.
   - ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
   - ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

☐ the description, pages:

☐ the claims, Nos.:

☐ the drawings, sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

(Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

6. Additional observations, if necessary:

III. Non-establishment of opinion with regard to novelty, inventive step and industrial applicability

1. The questions whether the claimed invention appears to be novel, to involve an inventive step (to be non-obvious), or to be industrially applicable have not been examined in respect of:

☐ the entire international application.

☒ claims Nos. 2-11,13,15,17-18,20-22.

because:

☐ the said international application, or the said claims Nos. relate to the following subject matter which does not require an international preliminary examination (*specify*):

☒ the description, claims or drawings (*indicate particular elements below*) or said claims Nos. are so unclear that no meaningful opinion could be formed (*specify*):
see separate sheet

☐ the claims, or said claims Nos. are so inadequately supported by the description that no meaningful opinion could be formed.

☐ no international search report has been established for the said claims Nos. .

2. A meaningful international preliminary examination cannot be carried out due to the failure of the nucleotide and/or amino acid sequence listing to comply with the standard provided for in Annex C of the Administrative Instructions:

☐ the written form has not been furnished or does not comply with the standard.

☐ the computer readable form has not been furnished or does not comply with the standard.

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	1,12,14,16,19
	No:	Claims	
Inventive step (IS)	Yes:	Claims	
	No:	Claims	1,12,14,16,19
Industrial applicability (IA)	Yes:	Claims	1-22
	No:	Claims	

2. Citations and explanations
see separate sheet

VIII. Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:
see separate sheet

1. Concerning Item I

Basis of the opinion

Reference is made to the following document:

D1: WO-A1-9904593

2. Concerning Item III

Non-establishment of opinion with regard to novelty, inventive step and industrial applicability

The present set of claims comprises two groups of independent claims on the same category (claims 1 and 12 and claims 14, 16 and 19, respectively) of overlapping and unclear scope (see item VIII) which makes practically impossible to carry out a complete examination with respect to novelty and inventive step of all claims.

3. Concerning Item V

Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

3.1 Despite of what is discussed in sections III and VIII, the examiner will, as a service to the applicant, now give an opinion on **independent claims 1, 12, 14, 16 and 19**.

3.2 The document D1 is regarded as being the closest prior art to the subject-matter of **claim 16**, and insofar as this claim can be understood (see Section VIII), this document shows the following features thereof (the references in parentheses applying to this document):

(i) A mobile station (see D1, page 4, line 37: "At the mobile station...") comprising:

(ii) means for determining a quality factor for a test cell (see D1, page 4, line 16-17: "means for determining power in the received signals...") and

(iii) means for determining quality factors for the cells in the active set (see D1, page 5, lines 1-3: "... which is the sum of the energies of the pilots in the active set."), characterised in that it further comprises

(iv) means for selecting an acceptance criterion (see D1, page 5, lines 3-8 : "... the optimum value of this threshold is determined by the mobile station itself...") and

(v) means for deciding about the acceptance of the test cell as a candidate cell for the active set using the acceptance criterion (see D1, page 5, lines 6-8: "If the strongest pilot in the candidate set satisfies this threshold condition, it is added to the revised active set...").

The subject-matter of claim 16 differs from D1 only in that in claim 16 a specific ratio between the first quality factor and the second quality factor is used (claim 16, lines 15-16 at page 17: "and the first quality factor is equal to the second quality factor multiplied with the same finite number") as well as the same specific ratio is disclosed between the quality factors grouped in a first and in a second set (claim 16, lines 17-18 at page 17: "the first set of quality factors is the same as a set formed of the quality factors belonging to the second set of quality factors multiplied with the same finite number"), which is not explicitly disclosed in D1.

It is however generally known to the person skilled in the art, that the feature of "the first quality factor being equal to the second quality factor multiplied by any finite number" is a commonly used direct ratio relation between quality factors, and that relation is also valid for the cells forming a set and not only for a single test cell.

Thus, the subject-matter of **claim 16** lacks an inventive step and does not meet the requirements of Article 33(3) PCT.

3.3 Regarding independent **claims 14 and 19**, the fact of including a certain arrangement (like the arrangement of claim 14) in a mobile station (claim 16) or in a network element (claim 19) is a routine procedure for the person skilled in the art and, therefore, doesn't imply any inventive activity.

Thus, the subject-matter of **claims 14 and 19** lacks an inventive step and does not meet the requirements of Article 33(3) PCT.

3.4 Independent **claim 1** (method for determining a candidate cell for an active set) contains in terms of method features all the features of claim 16.

A method for determining a cell to be removed from the active set as in independent **claim 12** is immediately derivable from D1 (see page 5, lines 9-12: "Following the iterative process performed on the members of the candidate set, a second iterative process is performed to determine whether a pilot should be deleted from the revised active set. In this operation, pilots are tested from the weakest member of revised active set to the strongest. A combined pilot energy value is computed that is the sum of the energies of all pilots belonging to the active set") as it also contains in terms of method features all the features of claim 16, without implying any inventive activity.

Therefore, the subject-matter of **claims 1 and 12** does not involve an inventive step in the sense of Article 33(3) PCT (see point 3.2 above).

3.5 The present invention is **susceptible of industrial application**, Article 33 (4) PCT.

4. Concerning Item VIII

Certain observations on the international application

The application does not meet the requirements of Article 6 PCT, because **independent claims 1, 12, 14, 16 and 19** are not clear for the following reasons:

4.1 Although **claims 1 and 12** and **claims 14 and 19** have been drafted as two

separate groups of independent claims, these claims appear to relate effectively to the same subject-matter, i.e. to a method and an apparatus for determining a candidate cell for an active set, respectively. The claims differ from each other only with regard to the definition of the subject-matter for which protection is sought. The aforementioned claims therefore lack conciseness. Moreover, lack of clarity of the claims as a whole arises, since the plurality of independent claims makes it difficult, if not impossible, to determine the matter for which protection is sought, and places an undue burden on others seeking to establish the extent of the protection.

4.2 Independent **claims 1, 12, 14, 16 and 19** are unclear because it is not clear what is meant by: "the acceptance criterion is selected that a first limit value..." in case of claim 1, "the rejection criterion is selected that a first limit value..." in case of claim 12, and "means for selecting an acceptance criterion, which defines a value for a limit for accepting a test cell, that a first limit value ..." in case of claims 14, 16 and 19. If what was meant was that: "an acceptance criterion is selected, in which a first limit value...", this should have been specified in the claims.

4.3 Furthermore, independent **claim 1** is also unclear since it is not clear what is meant by the terms in line 7: "which defines a value for a limit for accepting a test cell...". If what is meant is "which defines a value as a limit for accepting a test cell...", this should be specified in the claim.

Also in claim 1, line 8: "...characterised in that such an acceptance criterion..." should read "...characterised in that the acceptance criterion...", as this acceptance criterion was already mentioned in line 6: "the test cell is accepted as a candidate cell for the active set, if an acceptance criterion...".

4.4 In **claim 16**, it is not clear what is meant by: "means for selecting such an acceptance criterion...". Since the acceptance criterion has not been mentioned previously in the claim, claim 16 should read: "means for selecting an acceptance criterion...".

Hence, **claims 1, 12, 14, 16 and 19** do not meet the requirements of Article 6 PCT.

Figure 1 presents a schematic drawing of a cellular network which comprises base stations 101a, 101b and 101c. In Figure 1, these base stations are all connected to a single radio network controller 102 and each base station is in the middle of a cell. Figure 1 presents one mobile station 110. The base stations transmit downlink data to mobile stations (arrows 120a, 120b and 120c) and receive uplink data from mobile stations (arrows 121a, 121b and 121c).

In general a base station may comprise many transmitters, each of which transmit a separate radio signal. In systems employing CDMA methods, the transmitters may use different spreading codes. Here term cell is used to refer either to a base station or, if a base station comprises many transmitters, to a transmitter. In a situation where a mobile station receives good quality downlink transmissions from many cells, it has to be decided which cell a certain mobile station communicates with.

Usually the cellular network informs the mobile station of the possible cells, for example, selected based on the location of the mobile station. The information about the nearest cells is called neighbor list. In a cellular network which employs CDMA methods, the neighbor list may comprise the downlink spreading codes of the cells. By taking the spreading codes listed in the neighbor list into use, the mobile station may separate the data flows sent to it from each cell from the radio signal it receives. The neighbor list of the mobile station 110 may comprise, for example, the cells corresponding to base stations 101a, 101b and 101c, assuming that a base station corresponds to one cell.

Usually a pilot signal is transmitted in each cell. This pilot signal carries no changing data, so it can be quite straightforwardly used in estimating the quality of the downlink radio transmission of a certain cell. A mobile station may, for example, estimate the quality of the radio transmission of all the cells in the neighbor list. A suitable parameter for quality estimation is, for example in a cellular system employing CDMA methods, the E_C/I_0 ratio, where E_C is energy per chip and I_0 is the interference. Any other parameter measuring the quality of the signal may also be used.

The cells with which a mobile station communicates form the active set of that mobile station. A radio network controller, for example, directs the downlink data heading to a certain mobile station, to all the cells in the active set. Correspondingly, the mobile station listens to the downlink transmissions of all the cells in the active set. For example, the cells corresponding to base stations 101a and 101b can form the active set of the mobile station 110.

In the second example the active set contains also two cells, and now the quality factors are $P_1 = 3$ and $P_2 = 3$. The acceptance limit in this example is $Q = 9.5$ dB. The quality factors of the cells in the active set are 5 dB, so a cell has to have a quality factor 4.5 dB higher than the cells in the active set to be accepted to the active set. Correspondingly, expressed in absolute values, a cell should have a quality factor $P_C = 9.5$ to be accepted to the active set. Intuitively, the acceptance criterion should also in this second example produce the result that a test cell can be accepted to the active set if the quality factor of the cell is larger than 3.

The current acceptance criterion thus leads to situation where intuitively similar situations produce a different acceptance decision. A further problem with the acceptance criterion is that for an active set whose cells have the same quality factors, from here on called an uniform active set, the acceptance limit is not equal to the quality factor.

The object of the invention is to present a method for determining a candidate cell for the active set. A further object of the invention is to present a method where similar active sets and test cells produce the same acceptance decision. Further, it is advantageous that the method for determining a candidate cell accepts a cell whose quality factor is equal to the quality factor of an uniform active set.

The object of the invention is achieved by selecting the acceptance criterion so that it is indifferent to the absolute values of the quality factors.

A method according to the invention is a method for determining a candidate cell for an active set, where
- the quality factor of each cell in the active set is determined,
- a quality factor of a test cell is determined, and
- the test cell is accepted as a candidate cell for the active set, if an acceptance criterion, which defines a value for a limit for accepting a test cell, is fulfilled,

and the method is characterized in that such an acceptance criterion is selected that a first limit value is equal to a second limit value multiplied with a finite number, wherein said first limit value is for a certain first quality factor of a test cell and for a certain first set of quality factors, consisting of quality factors of cells in a first active set, said second limit value is for a certain second quality factor of a test cell and for a certain second set of quality factors, consisting of quality factors of cells in a second active set, and the first quality factor is equal to the second quality factor multiplied with the same finite number and the first set of quality factors is the same

as a set formed of the quality factors belonging to the second set of quality factors multiplied with the same finite number.

A method according to the invention is a method for determining a cell to be removed from the active set, where

- the quality factor of each cell in the active set is determined,
- a rejection criterion is evaluated using the cell having the smallest quality factor as a test cell and a temporary set, which contains the cells of the active set except the cell having the smallest quality factor, and
- the test cell is removed from the active set, if a rejection criterion, which defines a value for a limit for rejecting a test cell, is fulfilled,

and it is characterized in that such a rejection criterion is selected that a first limit value is equal to a second limit value multiplied with a finite number, wherein said first limit value is for a certain first quality factor of a test cell and for a certain first set of quality factors, consisting of quality factors of cells in a first temporary set, said second limit value is for a certain second quality factor of a test cell and for a certain second set of quality factors, consisting of quality factors of cells in a second temporary set, and the first quality factor is equal to the second quality factor multiplied with the same finite number and the first set of quality factors is the same as a set formed of the quality factors belonging to the second set of quality factors multiplied with the same finite number.

The invention relates also to an arrangement for determining a candidate cell for an active set comprising

- means for determining a quality factor for a test cell and
- means for determining quality factors for the cells in the active set, which arrangement is characterized in that it further comprises
- means for selecting such an acceptance criterion, which defines a value for a limit for accepting a test cell, that a first limit value is equal to a second limit value multiplied with a finite number, wherein said first limit value is for a certain first quality factor of a test cell and for a certain first set of quality factors, consisting of quality factors of cells in a first active set, the second limit value is for a certain second quality factor of a test cell and for a certain second set of quality factors, consisting of quality factors of cells in a second active set, and the first quality factor is equal to the second quality factor multiplied with the same finite number and the first set of quality factors is the same as a set formed of the quality factors belonging to the second set of quality factors multiplied with the same finite number and

- means for deciding about the acceptance of the test cell as a candidate cell for the active set using the acceptance criterion.

A mobile station according to the invention comprises
- means for determining a quality factor for a test cell and
- means for determining quality factors for the cells in the active set, and it is characterized in that it further comprises
- means for selecting such an acceptance criterion, which defines a limit for accepting a test cell, that a first limit value is equal to a second limit value multiplied with a finite number, wherein said first limit value is for a certain first quality factor of a test cell and for a certain first set of quality factors, consisting of quality factors of cells in a first active set, the second limit value is for a certain second quality factor of a test cell and for a certain second set of quality factors, consisting of quality factors of cells in a second active set, and the first quality factor is equal to the second quality factor multiplied with the same finite number and the first set of quality factors is the same as a set formed of the quality factors belonging to the second set of quality factors multiplied with the same finite number and
- means for deciding about the acceptance of the test cell as a candidate cell for the active set using the acceptance criterion.

The invention relates to a network element comprising
- means for determining a quality factor for a test cell and
- means for determining quality factors for the cells in the active set, which network element is characterized in that it further comprises
- means for selecting such an acceptance criterion, which defines a value for a limit for accepting a test cell, that a first limit value is equal to a second limit value multiplied with a finite number, wherein said first limit value is for a certain first quality factor of a test cell and for a certain first set of quality factors, consisting of quality factors of cells in a first active set, said second limit value is for a certain second quality factor of a test cell and for a certain second set of quality factors, consisting of quality factors of cells in a second active set, and the first quality factor is equal to the second quality factor multiplied with the same finite number and the first set of quality factors is the same as a set formed of the quality factors belonging to the second set of quality factors multiplied with the same finite number and
- means for deciding about the acceptance of the test cell as a candidate cell for the active set using the acceptance criterion.

In a method according to the invention, the quality factors of the cells in the active set are determined. Further, the quality factor of a test cell not in the active set but, for example, in the neighbor list is determined. The choice of the quality factors used in a method according to the invention is not restricted. The term accepting a test cell as a candidate cell for the active cell refers to a situation, where a mobile station or the cellular network notices that a certain cell has good enough quality factor, for example, to be added to the active set. The acceptance of a test cell as a candidate cell may trigger, for example, the transmission of the transmission quality reports from a mobile station to the cellular network. Thereafter the cellular network may decide whether the active set is modified.

In the method according to the invention, the acceptance criterion is selected so that it fulfills the following condition. The acceptance criterion Q' for a test cell having a quality factor P_T and for an active set having n cells, whose quality factors are P_1, P_2, ..., P_n, is $Q'(P_T, P_1, P_2, P_3, \ldots)$. The value $Q'(P_T, P_1, P_2, P_3, \ldots)$ is equal to the value of acceptance criterion for a test cell having a quality factor aP_T and for an active set having n cells, whose quality factors are aP_1, aP_2, ..., aP_n. Here a is any finite scalar number. The condition for the acceptance criterion can be written as

$$\forall a \quad Q'(aP_T, aP_1, aP_2, aP_3, \ldots) = Q'(P_T, P_1, P_2, P_3, \ldots).$$

The quality factor of the test cell and the quality factors of cells in the active set are not restricted, the condition holds for any values of P_T and P_i, where P_i is the quality factor of cell i in the active set. An example of a acceptance criterion fulfilling the condition is the following criterion where geometric mean is employed

$$Q'(P_T, P_1, P_2, \ldots): \quad P_T > \sqrt[n]{\prod P_i}$$

because $Q'(aP_T, aP_1, aP_2, aP_3, \ldots)$ is

$$Q'(aP_T, aP_1, aP_2, \ldots): \quad aP_T > \sqrt[n]{\prod aP_i} = \sqrt[n]{a^n}\sqrt[n]{\prod P_i} = a\sqrt[n]{\prod P_i}.$$

If for a certain value of P_T, $Q'(P_T, P_1, P_2, P_3, \ldots)$ is true, then $Q'(aP_T, aP_1, aP_2, aP_3, \ldots)$ is also true. In other words, if a test cell having quality factor P_T is accepted as a candidate cell for the active set whose cells have quality factors P_1 and P_2, a test cell having quality factor aP_T is accepted as a candidate cell for the active set whose cells have quality factors aP_1 and aP_2. It is possible to use only some of the quality factors of the cells in the active set in the acceptance criterion, but typically the quality factors of all cells in the active set are used.

In one embodiment of the invention said acceptance criterion involves a function, whose value depends at least on quality factors of first cells in the active set and on certain parameter values. Said acceptance criterion procudes a same value for said first quality factor of a test cell, said first set of quality factors and first parameter values as for said second quality factor of a test cell, said second set of quality factors and the same first parameter values, said first parameter values being any parameter values.

It may, however, be easier to normalized all the quality factors with a certain number and then use the normalized quality factors. The acceptance decision may, for example, be a function having the normalized quality factors as variables. The

Claims

1. A method (200, 300, 400) for determining a candidate cell for an active set, where
- the quality factor of each cell in the active set is determined (202),
- a quality factor of a test cell is determined (203), and
- the test cell is accepted (205) as a candidate cell for the active set, if an acceptance criterion, which defines a value for a limit for accepting a test cell, is fulfilled, **characterized** in that such an acceptance criterion is selected (201) that a first limit value is equal to a second limit value multiplied with a finite number, wherein said first limit value is for a certain first quality factor of a test cell and for a certain first set of quality factors, consisting of quality factors of cells in a first active set, said second limit value is for a certain second quality factor of a test cell and for a certain second set of quality factors, consisting of quality factors of cells in a second active set, and the first quality factor is equal to the second quality factor multiplied with the same finite number and the first set of quality factors is the same as a set formed of the quality factors belonging to the second set of quality factors multiplied with the same finite number.

2. A method according to claim 1, **characterized** in that said acceptance criterion involves a function, whose value depends at least on quality factors of first cells in the active set and on certain parameter values, and in that said acceptance criterion produces a first limit value for said first quality factor of a test cell, said first set of quality factors and first parameter values, which first limit value is equal to a second limit value multiplied with the finite number, said second limit value being for said second quality factor of a test cell, said second set of quality factors and said first parameter values, said first parameter values being any parameter values.

3. A method (300, 400) according to claim 1, **characterized** in that
- the quality factor of the test cell and the quality factors of the cells in the active set are normalized (301) with a number having a predefined relative value compared to the values of the quality factors of the cells in the active set,
- a value for the limit is determined (302) using the normalized quality factors of the cells in the active set and the normalized quality factor of the test cell and
- the test cell is accepted (303, 205) as a candidate cell, if the acceptance criterion is fulfilled.

4. A method (300, 400) according to claim 3, **characterized** in that the quality factors are normalized using the largest quality factor of the quality factors of the cells in the active set.

5. A method (300, 400) according to claim 3, **characterized** in that the quality factors are normalized using the smallest quality factor of the quality factors of the cells in the active set.

6. A method (300, 400) according to claim 3, **characterized** in that the quality factors are normalized using the average quality factor of the quality factors of the cells in the active set.

7. A method (400) according to claim 1, **characterized** in that the acceptance criterion is such that for an active set where all the cells have a certain quality factor the limit is that certain quality factor.

8. A method according to claim 1, **characterized** in that the method is executed periodically.

9. A method according to claim 1, **characterized** in that the method is triggered by a certain event.

10. A method according to claim 1, **characterized** in that the candidate cell is added to the active set.

11. A method according to claim 1, **characterized** in that the cell having the worst quality factor in the active set is replaced with the candidate cell.

12. A method for determining a cell to be removed from the active set, where
- the quality factor of each cell in the active set is determined,
- a rejection criterion is evaluated using the cell having the smallest quality factor as a test cell and a temporary set, which contains the cells of the active set except the cell having the smallest quality factor, and
- the test cell is removed from the active set, if a rejection criterion, which defines a value for a limit for rejecting a test cell, is fulfilled, **characterized** in that such a rejection criterion is selected that a first limit value is equal to a second limit value multiplied with a finite number, wherein said first limit value is for a certain first quality factor of a test cell and for a certain first set of quality factors, consisting of quality factors of cells in a first temporary set, the second limit value is for a certain second quality factor of a test cell and for a certain second set of quality factors,

consisting of quality factors of cells in a second temporary set, and the first quality factor is equal to the second quality factor multiplied with the same finite number and the first set of quality factors is the same as a set formed of the quality factors belonging to the second set of quality factors multiplied with the same finite number.

13. A method according to claim 12, **characterized** in that said rejection criterion involves a function, whose value depends at least on quality factors of first cells in the temporary set and on certain parameter values, and in that said rejection criterion produces a first limit value for said first quality factor of a test cell, said first set of quality factors and first parameter values, which first limit value is equal to a second limit value multiplied with the same finite number, the second limit value being for said second quality factor of a test cell, said second set of quality factors and said first parameter values, said first parameter values being any parameter values.

14. An arrangement (500) for determining a candidate cell for an active set comprising
- means (501) for determining a quality factor for a test cell and
- means (502) for determining quality factors for the cells in the active set, **characterized** in that it further comprises
- means (503) for selecting such an acceptance criterion, which defines a value for a limit for accepting a test cell, that a first limit value is equal to a second limit value multiplied with a finite number, wherein said first limit value is for a certain first quality factor of a test cell and for a certain first set of quality factors, consisting of quality factors of cells in a first active set, the second limit value is for a certain second quality factor of a test cell and for a certain second set of quality factors, consisting of quality factors of cells in a second active set, and the first quality factor is equal to the second quality factor multiplied with the same finite number and the first set of quality factors is the same as a set formed of the quality factors belonging to the second set of quality factors multiplied with the same finite number and
- means (504) for deciding about the acceptance of the test cell as a candidate cell for the active set using the acceptance criterion.

15. An arrangement according to claim 14, **characterized** in that said acceptance criterion involves a function, whose value depends at least on quality factors of first cells in the active set and on certain parameter values, and in that said acceptance criterion produces a first limit value for said first quality factor of a test cell, said first set of quality factors and first parameter values, which first limit value is equal

to a second limit value multiplied with the finite number, the second limit value being for said second quality factor of a test cell, said second set of quality factors and said first parameter values, said first parameter values being any parameter values.

16. A mobile station (510) comprising
- means (501) for determining a quality factor for a test cell and
- means (502) for determining quality factors for the cells in the active set, **characterized** in that it further comprises
- means (503) for selecting such an acceptance criterion, which defines a limit for accepting a test cell, that a first limit value is equal to a second limit value multiplied with a finite number, wherein said first limit value is for a certain first quality factor of a test cell and for a certain first set of quality factors, consisting of quality factors of cells in a first active set, the second limit value is for a certain second quality factor of a test cell and for a certain second set of quality factors, consisting of quality factors of cells in a second active set, and the first quality factor is equal to the second quality factor multiplied with the same finite number and the first set of quality factors is the same as a set formed of the quality factors belonging to the second set of quality factors multiplied with the same finite number and
- means (504) for deciding about the acceptance of the test cell as a candidate cell for the active set using the acceptance criterion.

17. A mobile station according to claim 16, **characterized** in that said acceptance criterion involves a function, whose value depends at least on quality factors of first cells in the active set and on certain parameter values, and in that said acceptance criterion produces a first limit value for said first quality factor of a test cell, said first set of quality factors and first parameter values, which first limit value is equal to a second limit value multiplied with the finite number, the second limit value being for said second quality factor of a test cell, said second set of quality factors and said first parameter values, said first parameter values being any parameter values.

18. A mobile station according to claim 16, **characterized** in that it is a mobile station of an Universal Mobile Communication System.

19. A network element (520) comprising
- means (501) for determining a quality factor for a test cell and

- means (502) for determining quality factors for the cells in the active set, **characterized** in that it further comprises
- means (503) for selecting such an acceptance criterion, which defines a value for a limit for accepting a test cell, that a first limit value is equal to a second limit value multiplied with a finite number, wherein said first limit value is for a certain first quality factor of a test cell and for a certain first set of quality factors, consisting of quality factors of cells in a first active set, said second limit value is for a certain second quality factor of a test cell and for a certain second set of quality factors, consisting of quality factors of cells in a second active set, and the first quality factor is equal to the second quality factor multiplied with the same finite number and the first set of quality factors is the same as a set formed of the quality factors belonging to the second set of quality factors multiplied with the same finite number and
- means (504) for deciding about the acceptance of the test cell as a candidate cell for the active set using the acceptance criterion.

20. A network element according to claim 19, **characterized** in that it is a network element of the radio access network of the Universal Mobile Communication System.

21. A network element according to claim 20, **characterized** in that it is a Radio Network Controller.

22. A network element according to claim 19, **characterized** in that said acceptance criterion involves a function, whose value depends at least on quality factors of first cells in the active set and on certain parameter values, and in that said acceptance criterion produces a first limit value for said first quality factor of a test cell, said first set of quality factors and first parameter values, which first limit value is equal to a second limit value multiplied with the finite number, the second limit value being for said second quality factor of a test cell, said second set of quality factors and said first parameter values, said first parameter values being any parameter values.

PATENT COOPERATION TREATY

From the:
INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

To:

BERGGREN OY AB
P.O. Box 16
FIN-00101 Helsinki
FINLANDE

Skul/plm

PCT

WRITTEN OPINION

(PCT Rule 66)

Date of mailing *(day/month/year)*	06.09.2001
Applicant's or agent's file reference: BP100152	**REPLY DUE** **within 2 month(s)** from the above date of mailing 7.6/11-01

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/FI00/00796	20/09/2000	20/09/1999

International Patent Classification (IPC) or both national classification and IPC

H04Q7/38

Applicant

NOKIA NETWORKS OY et al.

1. This written opinion is the **first** drawn up by this International Preliminary Examining Authority.

2. This opinion contains indications relating to the following items:

I	☒	Basis of the opinion
II	☐	Priority
III	☒	Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
IV	☐	Lack of unity of invention
V	☒	Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
VI	☐	Certain document cited
VII	☒	Certain defects in the international application
VIII	☒	Certain observations on the international application

3. The applicant is hereby **invited to reply** to this opinion.

When? See the time limit indicated above. The applicant may, before the expiration of that time limit, request this Authority to grant an extension, see Rule 66.2(d).

How? By submitting a written reply, accompanied, where appropriate, by amendments, according to Rule 66.3. For the form and the language of the amendments, see Rules 66.8 and 66.9.

Also: For an additional opportunity to submit amendments, see Rule 66.4. For the examiner's obligation to consider amendments and/or arguments, see Rule 66.4 bis. For an informal communication with the examiner, see Rule 66.6.

If no reply is filed, the international preliminary examination report will be established on the basis of this opinion.

4. The final date by which the international preliminary examination report must be established according to Rule 69.2 is: 20/01/2002.

Name and mailing address of the international preliminary examining authority:

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Authorized officer / Examiner
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I. Basis of the opinion

1. With regard to the **elements** of the international application (Replacement *sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this opinion as "originally filed"*):

Description, pages:

1-13 as originally filed

Claims, No.:

1-22 as originally filed

Drawings, sheets:

1/5-5/5 as originally filed

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language: , which is:

- ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

- ☐ the description, pages:
- ☐ the claims, Nos.:

☐ the drawings, sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

(Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

6. Additional observations, if necessary:

III. Non-establishment of opinion with regard to novelty, inventive step and industrial applicability

1. The questions whether the claimed invention appears to be novel, to involve an inventive step (to be non-obvious), or to be industrially applicable have not been and will not be examined in respect of:

☐ the entire international application,

☒ claims Nos. 2-11,13,15,17-18, 20-22,

because:

☐ the said international application, or the said claims Nos. relate to the following subject matter which does not require an international preliminary examination (*specify*):

☒ the description, claims or drawings (*indicate particular elements below*) or said claims Nos. are so unclear that no meaningful opinion could be formed (*specify*):
see separate sheet

☐ the claims, or said claims Nos. are so inadequately supported by the description that no meaningful opinion could be formed.

☐ no international search report has been established for the said claims Nos. .

2. A written opinion cannot be drawn due to the failure of the nucleotide and/or amino acid sequence listing to comply with the standard provided for in Annex C of the Administrative Instructions:

☐ the written form has not been furnished or does not comply with the standard.

☐ the computer readable form has not been furnished or does not comply with the standard.

V. Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Claims	
Inventive step (IS)	Claims	1,12,14,16,19

Industrial applicability (IA) Claims

2. Citations and explanations
see separate sheet

VII. Certain defects in the international application

The following defects in the form or contents of the international application have been noted:
see separate sheet

VIII. Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:
see separate sheet

1. Concerning Item I

Basis of the opinion

Reference is made to the following document:

D1: WO-A1-9904593

2. Concerning Item III

Non-establishment of opinion with regard to novelty, inventive step and industrial applicability

The present set of claims comprises two groups of independent claims on the same category (claims 1 and 12 and claims 14, 16 and 19, respectively) of overlapping and unclear scope (see item VIII) which makes practically impossible to carry out a complete examination with respect to novelty and inventive step of all claims.

3. Concerning Item V

Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

3.1 Despite of what is discussed in sections III and VIII, and although it is not clear how the applicant will amend the claims to render them concise, the examiner will, in order to expedite the proceedings and as a service to the applicant, already now give an opinion on **independent claims 1, 12, 14, 16 and 19**.

3.2 The document D1 is regarded as being the closest prior art to the subject-matter of **claim 14**, and insofar as this claim can be understood (see Section VIII), this document shows the following features thereof (the references in parentheses applying to this document):

(i) A mobile station (see D1, page 4, line 37: "At the mobile station...") comprising:

(ii) means for determining a quality factor for a test cell (see D1, page 4, line 16-17: "means for determining power in the received signals...") and

(iii) means for determining quality factors for the cells in the active set (see D1, page 5, lines 1-3: "... which is the sum of the energies of the pilots in the active set."), characterised in that it further comprises

(iv) means for selecting an acceptance criterion (see D1, page 5, lines 3-8 : "... the optimum value of this threshold is determined by the mobile station itself...") and

(v) means for deciding about the acceptance of the test cell as a candidate cell for the active set using the acceptance criterion (see D1, page 5, lines 6-8: "If the strongest pilot in the candidate set satisfies this threshold condition, it is added to the revised active set...").

The subject-matter of claim 1 differs from D1 only in that in claim 1 a specific ratio between the first quality factor and the second quality factor is used ("when the first quality factor is equal to the second quality factor multiplied with any finite number") as well as the same specific ratio is disclosed between the quality factors grouped in a first and in a second set (the first set of quality factors is the same as a set formed of the quality factors belonging to the second set of quality factors multiplied with the same finite number), which is not explicitly disclosed in D1.

It is however generally known to the person skilled in the art, that the feature of "the first quality factor being equal to the second quality factor multiplied by any finite number" is a commonly used direct ratio relation between quality factors, and that relation is also valid for the cells forming a set and not only for a single test cell.

Thus, the subject-matter of **claim 14** lacks an inventive step and does not meet the requirements of Article 33(3) PCT.

3.3 Regarding independent **claims 16 and 19**, the fact of including a certain arrangement (like the arrangement of claim 14) in a mobile station (claim 16) or in a network element (claim 19) is a routine procedure for the person skilled in the art and, therefore, doesn't imply any inventive activity.

Thus, the subject-matter of **claims 16 and 19** lacks an inventive step and does not meet the requirements of Article 33(3) PCT.

3.4 Independent **claim 1** (method for determining a candidate cell for an active set) contains in terms of method features all the features of claim 14.

A method for determining a cell to be removed from the active set as in independent **claim 12** is immediately derivable from D1 (see page 5, lines 9-12: "Following the iterative process performed on the members of the candidate set, a second iterative process is performed to determine whether a pilot should be deleted from the revised active set. In this operation, pilots are tested from the weakest member of revised active set to the strongest. A combined pilot energy value is computed that is the sum of the energies of all pilots belonging to the active set") as it also contains in terms of method features all the features of claim 14, whithout implying any inventive activity.

Therefore, the subject-matter of **claims 1 and 12** does not involve an inventive step in the sense of Article 33(3) PCT (see point 3.2 above).

4. Concerning Item VII

Certain defects in the international application

If the applicant wishes to proceed with the application the following matters should also receive attention:

The opening part of the description should be brought into conformity with the wording of the claim of broadest scope as finally amended.

In page 2, lines 2-4 of the description, cells 111a, 111b and 111c are mentioned referring to Figure 1. Those reference signs were not found in Figure 1.

In order to facilitate the examination of the conformity of the amended application with the requirements of Article 19(2), 34(2) PCT, the applicant is requested to clearly identify the amendments carried out, irrespective of whether they concern amendments by addition, replacement or deletion, and to indicate the passages of the application as filed on which these amendments are based.

The attention of the applicant is finally drawn to the fact that the application should, for reasons of conciseness, include only the minimum necessary number of independent claims comprising all the essential technical features of the invention (Rule 6.4(a)-(c) PCT) and may not be amended in such a way that it contains subject-matter beyond the content of the application as originally filed (Articles 19(2) and 34(2) (b) PCT).

5. Concerning Item VIII

Certain observations on the international application

5.1 Although **claims 1 and 12** and **claims 14 and 19** have been drafted as two separate groups of independent claims, these claims appear to relate effectively to the same subject-matter, i.e. to a method and an apparatus for determining a candidate cell for an active set, respectively. The claims differ from each other only with regard to the definition of the subject-matter for which protection is sought. The aforementioned claims therefore lack conciseness. Moreover, lack of clarity of the claims as a whole arises, since the plurality of independent claims makes it difficult, if not impossible, to determine the matter for which protection is sought, and places an undue burden on others seeking to establish the extent of the protection.

Hence, **claims 1, 12, 14 and 19** do not meet the requirements of Article 6 PCT.

In order to overcome this objection, it would appear appropriate to file an amended set of claims defining the relevant subject-matter in terms of one independent apparatus claim and a method claim followed by dependent claims

covering features which are merely optional (Rule 6.4 PCT)

5.2 The application does not meet the requirements of Article 6 PCT, because **independent claims 1, 12, 14, 16 and 19** are not clear for the following reasons:

Independent claims 1, 14, 16 and 19 are not clear since it is unclear what is meant by "the acceptance criterion has the same value as for a certain second set of quality factors...", because it is not clear how can a criterion have a value. If what is meant is that the criterion includes a certain threshold, and that "...said threshold has the same value as for a certain second set of quality factors...", this should be specified in the claims.

The same clarity problem arises in **claim 12** but regarding the rejection criterion.

Furthermore, independent **claims 1, 14, 16 and 19** are also unclear because the claims are referring to the result to be achieved ("the acceptance criterion is selected so that for a certain..." in case of claim 1 and "means for selecting an acceptance criterion so that for a certain first quality factor of a test cell and for a certain first set of quality factors ... the acceptance criterion has the same value as for a certain second quality factor of a test cell and for a certain second set of quality factors " in case of claims 14, 16 and 19), but it is not disclosed how to arrive at that result and, therefore, the skilled person would not know how to choose the appropriate way of implementing said method or apparatus, respectively.

REPLACED BY ART 34 AMDT

Claims

1. A method (200, 300, 400) for determining a candidate cell for an active set, where
- the quality factor of each cell in the active set is determined (202),
- a quality factor of a test cell is determined (203), and
- the test cell is accepted (205) as a candidate cell for the active set if an acceptance criterion is fulfilled, **characterized** in that the acceptance criterion is selected (201) so that for a certain first quality factor of a test cell and for a certain first set of quality factors, consisting of quality factors of cells in a first active set, the acceptance criterion has the same value as for a certain second quality factor of a test cell and for a certain second set of quality factors, consisting of quality factors of cells in a second active set, when the first quality factor is equal to the second quality factor multiplied with any finite number and the first set of quality factors is the same as a set formed of the quality factors belonging to the second set of quality factors multiplied with the same finite number.

2. A method according to claim 1, **characterized** in that said acceptance criterion involves a function, whose value depends at least on quality factors of first cells in the active set and on certain parameter values, and in that said acceptance criterion procudes a same value for said first quality factor of a test cell, said first set of quality factors and first parameter values as for said second quality factor of a test cell, said second set of quality factors and said first parameter values, said first parameter values being any parameter values.

3. A method (300, 400) according to claim 1, **characterized** in that
- the quality factor of the test cell and the quality factors of the cells in the active set are normalized (301) with a number having a certain relative value compared to the values of the quality factors of the cells in the active set,
- a value for the acceptance criterion is determined (302) using the normalized quality factors of the cells in the active set and the normalized quality factor of the test cell and
- the test cell is accepted (303, 205) as a candidate cell, if the acceptance criterion is fulfilled.

4. A method (300, 400) according to claim 3, **characterized** in that the quality factors are normalized using the largest quality factor of the quality factors of the cells in the active set.

5. A method (300, 400) according to claim 3, **characterized** in that the quality factors are normalized using the smallest quality factor of the quality factors of the cells in the active set.

6. A method (300, 400) according to claim 3, **characterized** in that the quality factors are normalized using the average quality factor of the quality factors of the cells in the active set.

7. A method (400) according to claim 1, **characterized** in that the acceptance criterion is adjusted (402) so that for an active set where all the cells have a certain quality factor the acceptance criterion is that certain quality factor.

8. A method according to claim 1, **characterized** in that the method is executed periodically.

9. A method according to claim 1, **characterized** in that the method is triggered by a certain event.

10. A method according to claim 1, **characterized** in that the candidate cell is added to the active set.

11. A method according to claim 1, **characterized** in that the cell having the worst quality factor in the active set is replaced with the candidate cell.

12. A method for determining a cell to be removed from the active set, where
- the quality factor of each cell in the active set is determined,
- a rejection criterion is evaluated using the cell having the smallest quality factor as a test cell and a temporary set, which contains the cells of the active set except the cell having the smallest quality factor, and
- the test cell is removed from the active set if a rejection criterion is fulfilled, **characterized** in that the rejection criterion is selected so that for a certain first quality factor of a test cell and for a certain first set of quality factors, consisting of quality factors of cells in a first temporary set, the rejection criterion has the same value as for a certain second quality factor of a test cell and for a certain second set of quality factors, consisting of quality factors of cells in a second temporary set, when the first quality factor is equal to the second quality factor multiplied with any finite number and the first set of quality factors is the same as a set formed of the quality factors belonging to the second set of quality factors multiplied with the same finite number.

13. A method according to claim 12, **characterized** in that said rejection criterion involves a function, whose value depends at least on quality factors of first cells in the active set and on certain parameter values, and in that said rejection criterion procudes a same value for said first quality factor of a test cell, said first set of quality factors and first parameter values as for said second quality factor of a test cell, said second set of quality factors and said first parameter values, said first parameter values being any parameter values.

14. An arrangement (500) for determining a candidate cell for an active set comprising
- means (501) for determining a quality factor for a test cell and
- means (502) for determining quality factors for the cells in the active set, **characterized** in that it further comprises
- means (503) for selecting an acceptance criterion so that for a certain first quality factor of a test cell and for a certain first set of quality factors, consisting of quality factors of cells in a first active set, the acceptance criterion has the same value as for a certain second quality factor of a test cell and for a certain second set of quality factors, consisting of quality factors of cells in a second active set, when the first quality factor is equal to the second quality factor multiplied with any finite number and the first set of quality factors is the same as a set formed of the quality factors belonging to the second set of quality factors multiplied with the same finite number and
- means (504) for deciding about the acceptance of the test cell as a candidate cell for the active set using the acceptance criterion.

15. An arrangement according to claim 14, **characterized** in that said acceptance criterion involves a function, whose value depends at least on quality factors of first cells in the active set and on certain parameter values, and in that said acceptance criterion procudes a same value for said first quality factor of a test cell, said first set of quality factors and first parameter values as for said second quality factor of a test cell, said second set of quality factors and said first parameter values, said first parameter values being any parameter values.

16. A mobile station (510) comprising
- means (501) for determining a quality factor for a test cell and
- means (502) for determining quality factors for the cells in the active set, **characterized** in that it further comprises
- means (503) for selecting an acceptance criterion so that for a certain first quality factor of a test cell and for a certain first set of quality factors, consisting of quality

factors of cells in a first active set, the acceptance criterion has the same value as for a certain second quality factor of a test cell and for a certain second set of quality factors, consisting of quality factors of cells in a second active set, when the first quality factor is equal to the second quality factor multiplied with any finite number and the first set of quality factors is the same as a set formed of the quality factors belonging to the second set of quality factors multiplied with the same finite number and

- means (504) for deciding about the acceptance of the test cell as a candidate cell for the active set using the acceptance criterion.

17. A mobile station according to claim 16, **characterized** in that said acceptance criterion involves a function, whose value depends at least on quality factors of first cells in the active set and on certain parameter values, and in that said acceptance criterion procudes a same value for said first quality factor of a test cell, said first set of quality factors and first parameter values as for said second quality factor of a test cell, said second set of quality factors and said first parameter values, said first parameter values being any parameter values.

18. A mobile station according to claim 16, **characterized** in that it is a mobile station of an Universal Mobile Communication System.

19. A network element (520) comprising

- means (501) for determining a quality factor for a test cell and
- means (502) for determining quality factors for the cells in the active set, **characterized** in that it further comprises
- means (503) for selecting an acceptance criterion so that for a certain first quality factor of a test cell and for a certain first set of quality factors, consisting of quality factors of cells in a first active set, the acceptance criterion has the same value as for a certain second quality factor of a test cell and for a certain second set of quality factors, consisting of quality factors of cells in a second active set, when the first quality factor is equal to the second quality factor multiplied with any finite number and the first set of quality factors is the same as a set formed of the quality factors belonging to the second set of quality factors multiplied with the same finite number and
- means (504) for deciding about the acceptance of the test cell as a candidate cell for the active set using the acceptance criterion.

20. A network element according to claim 19, **characterized** in that it is a network element of the radio access network of the Universal Mobile Communication System.

21. A network element according to claim 20, **characterized** in that it is a Radio Network Controller.

22. A network element according to claim 19, **characterized** in that said acceptance criterion involves a function, whose value depends at least on quality factors of first cells in the active set and on certain parameter values, and in that said acceptance criterion procudes a same value for said first quality factor of a test cell, said first set of quality factors and first parameter values as for said second quality factor of a test cell, said second set of quality factors and said first parameter values, said first parameter values being any parameter values.

Figure 1 presents a schematic drawing of a cellular network which comprises base stations 101a, 101b and 101c. In Figure 1, these base stations are all connected to a single radio network controller 102 and each base station is in the middle of a cell 111a, 111b and 111c. Figure 1 presents one mobile station 110. The base stations transmit downlink data to mobile stations (arrows 120a, 120b and 120c) and receive uplink data from mobile stations (arrows 121a, 121b and 121c).

In general a base station may comprise many transmitters, each of which transmit a separate radio signal. In systems employing CDMA methods, the transmitters may use different spreading codes. Here term cell is used to refer either to a base station or, if a base station comprises many transmitters, to a transmitter. In a situation where a mobile station receives good quality downlink transmissions from many cells, it has to be decided which cell a certain mobile station communicates with.

Usually the cellular network informs the mobile station of the possible cells, for example, selected based on the location of the mobile station. The information about the nearest cells is called neighbor list. In a cellular network which employs CDMA methods, the neighbor list may comprise the downlink spreading codes of the cells. By taking the spreading codes listed in the neighbor list into use, the mobile station may separate the data flows sent to it from each cell from the radio signal it receives. The neighbor list of the mobile station 110 may comprise, for example, the cells corresponding to base stations 101a, 101b and 101c, assuming that a base station corresponds to one cell.

Usually a pilot signal is transmitted in each cell. This pilot signal carries no changing data, so it can be quite straightforwardly used in estimating the quality of the downlink radio transmission of a certain cell. A mobile station may, for example, estimate the quality of the radio transmission of all the cells in the neighbor list. A suitable parameter for quality estimation is, for example in a cellular system employing CDMA methods, the E_C/I_0 ratio, where E_C is energy per chip and I_0 is the interference. Any other parameter measuring the quality of the signal may also be used.

The cells with which a mobile station communicates form the active set of that mobile station. A radio network controller, for example, directs the downlink data heading to a certain mobile station, to all the cells in the active set. Correspondingly, the mobile station listens to the downlink transmissions of all the cells in the active set. For example, the cells corresponding to base stations 101a and 101b can form the active set of the mobile station 110.

In the second example the active set contains also two cells, and now the quality factors are $P_1 = 3$ and $P_2 = 3$. The acceptance limit in this example is $Q = 9.5$ dB. The quality factors of the cells in the active set are 5 dB, so a cell has to have a quality factor 4.5 dB higher than the cells in the active set to be accepted to the active set. Correspondingly, expressed in absolute values, a cell should have a quality factor $P_C = 9.5$ to be accepted to the active set. Intuitively, the acceptance criterion should also in this second example produce the result that a test cell can be accepted to the active set if the quality factor of the cell is larger than 3.

The current acceptance criterion thus leads to situation where intuitively similar situations produce a different acceptance decision. A further problem with the acceptance criterion is that for an active set whose cells have the same quality factors, from here on called an uniform active set, the acceptance limit is not equal to the quality factor.

The object of the invention is to present a method for determining a candidate cell for the active set. A further object of the invention is to present a method where similar active sets and test cells produce the same acceptance decision. Further, it is advantageous that the method for determining a candidate cell accepts a cell whose quality factor is equal to the quality factor of an uniform active set.

The object of the invention is achieved by selecting the acceptance criterion so that it is indifferent to the absolute values of the quality factors.

A method according to the invention is a method for determining a candidate cell for an active set, where
- the quality factor of each cell in the active set is determined,
- a quality factor of a test cell is determined, and
- the test cell is accepted as a candidate cell for the active set if an acceptance criterion is fulfilled, and the method is characterized in that the acceptance criterion is selected so that for a certain first quality factor of a test cell and for a certain first set of quality factors, consisting of quality factors of cells in a first active set, the acceptance criterion has the same value as for a certain second quality factor of a test cell and for a certain second set of quality factors, consisting of quality factors of cells in a second active set, when the first quality factor is equal to the second quality factor multiplied with any finite number and the first set of quality factors is the same as a set formed of the quality factors belonging to the second set of quality factors multiplied with the same finite number.

A method according to the invention is a method for determining a cell to be removed from the active set, where

- the quality factor of each cell in the active set is determined,
- a rejection criterion is evaluated using the cell having the smallest quality factor as a test cell and a temporary set, which contains the cells of the active set except the cell having the smallest quality factor, and
- the test cell is removed from the active set if a rejection criterion is fulfilled, and it is characterized in that the rejection criterion is selected so that for a certain first quality factor of a test cell and for a certain first set of quality factors, consisting of quality factors of cells in a first temporary set, the rejection criterion has the same value as for a certain second quality factor of a test cell and for a certain second set of quality factors, consisting of quality factors of cells in a second temporary set, when the first quality factor is equal to the second quality factor multiplied with any finite number and the first set of quality factors is the same as a set formed of the quality factors belonging to the second set of quality factors multiplied with the same finite number.

The invention relates also to an arrangement for determining a candidate cell for an active set comprising

- means for determining a quality factor for a test cell and
- means for determining quality factors for the cells in the active set, which arrangement is characterized in that it further comprises
- means for selecting an acceptance criterion so that for a certain first quality factor of a test cell and for a certain first set of quality factors, consisting of quality factors of cells in a first active set, the acceptance criterion has the same value as for a certain second quality factor of a test cell and for a certain second set of quality factors, consisting of quality factors of cells in a second active set, when the first quality factor is equal to the second quality factor multiplied with any finite number and the first set of quality factors is the same as a set formed of the quality factors belonging to the second set of quality factors multiplied with the same finite number and
- means for deciding about the acceptance of the test cell as a candidate cell for the active set using the acceptance criterion.

A mobile station according to the invention comprises

- means for determining a quality factor for a test cell and
- means for determining quality factors for the cells in the active set, and it is characterized in that it further comprises

- means for selecting an acceptance criterion so that for a certain first quality factor of a test cell and for a certain first set of quality factors, consisting of quality factors of cells in a first active set, the acceptance criterion has the same value as for a certain second quality factor of a test cell and for a certain second set of quality factors, consisting of quality factors of cells in a second active set, when the first quality factor is equal to the second quality factor multiplied with any finite number and the first set of quality factors is the same as a set formed of the quality factors belonging to the second set of quality factors multiplied with the same finite number and
- means for deciding about the acceptance of the test cell as a candidate cell for the active set using the acceptance criterion.

The invention relates to a network element comprising
- means for determining a quality factor for a test cell and
- means for determining quality factors for the cells in the active set, which network element is characterized in that it further comprises
- means for selecting an acceptance criterion so that for a certain first quality factor of a test cell and for a certain first set of quality factors, consisting of quality factors of cells in a first active set, the acceptance criterion has the same value as for a certain second quality factor of a test cell and for a certain second set of quality factors, consisting of quality factors of cells in a second active set, when the first quality factor is equal to the second quality factor multiplied with any finite number and the first set of quality factors is the same as a set formed of the quality factors belonging to the second set of quality factors multiplied with the same finite number and
- means for deciding about the acceptance of the test cell as a candidate cell for the active set using the acceptance criterion.

In a method according to the invention, the quality factors of the cells in the active set are determined. Further, the quality factor of a test cell not in the active set but, for example, in the neighbor list is determined. The choice of the quality factors used in a method according to the invention is not restricted. The term accepting a test cell as a candidate cell for the active cell refers to a situation, where a mobile station or the cellular network notices that a certain cell has good enough quality factor, for example, to be added to the active set. The acceptance of a test cell as a candidate cell may trigger, for example, the transmission of the transmission quality reports from a mobile station to the cellular network. Thereafter the cellular network may decide whether the active set is modified.

In the method according to the invention, the acceptance criterion is selected so that it fulfills the following condition. The acceptance criterion Q' for a test cell having a quality factor P_T and for an active set having n cells, whose quality factors are P_1, P_2, ..., P_n, is $Q'(P_T, P_1, P_2, P_3, \ldots)$. The value $Q'(P_T, P_1, P_2, P_3, \ldots)$ is equal to the value of acceptance criterion for a test cell having a quality factor aP_T and for an active set having n cells, whose quality factors are aP_1, aP_2, ..., aP_n. Here a is any infinite scalar number. The condition for the acceptance criterion can be written as

$$\forall a \quad Q'(aP_T, aP_1, aP_2, aP_3, \ldots) = Q'(P_T, P_1, P_2, P_3, \ldots).$$

The quality factor of the test cell and the quality factors of cells in the active set are not restricted, the condition holds for any values of P_T and P_i, where P_i is the quality factor of cell i in the active set. An example of a acceptance criterion fulfilling the condition is the following criterion where geometric mean is employed

$$Q'(P_T, P_1, P_2, \ldots): \quad P_T > \sqrt[n]{\prod P_i}$$

because $Q'(aP_T, aP_1, aP_2, aP_3, \ldots)$ is

$$Q'(aP_T, aP_1, aP_2, \ldots): \quad aP_T > \sqrt[n]{\prod aP_i} = \sqrt[n]{a^n}\sqrt[n]{\prod P_i} = a\sqrt[n]{\prod P_i}.$$

If for a certain value of P_T, $Q'(P_T, P_1, P_2, P_3, \ldots)$ is true, then $Q'(aP_T, aP_1, aP_2, aP_3, \ldots)$ is also true. In other words, if a test cell having quality factor P_T is accepted as a candidate cell for the active set whose cells have quality factors P_1 and P_2, a test cell having quality factor aP_T is accepted as a candidate cell for the active set whose cells have quality factors aP_1 and aP_2. It is possible to use only some of the quality factors of the cells in the active set in the acceptance criterion, but typically the quality factors of all cells in the active set are used.

In one embodiment of the invention said acceptance criterion involves a function, whose value depends at least on quality factors of first cells in the active set and on certain parameter values. Said acceptance criterion procudes a same value for said first quality factor of a test cell, said first set of quality factors and first parameter values as for said second quality factor of a test cell, said second set of quality factors and the same first parameter values, said first parameter values being any parameter values.

It may, however, be easier to normalized all the quality factors with a certain number and then use the normalized quality factors. The acceptance decision may, for example, be a function having the normalized quality factors as variables. The

The demand must be filed directly with the competent International Preliminary Examining Authority or, if two or more Authorities are competent, with the one chosen by the applicant. The full name or two-letter code of that Authority may be indicated by the applicant on the line below:

IPEA/ EP

PCT

CHAPTER II

DEMAND

under Article 31 of the Patent Cooperation Treaty:
The undersigned requests that the international application specified below be the subject of international preliminary examination according to the Patent Cooperation Treaty and hereby elects all eligible States (except where otherwise indicated).

For International Preliminary Examining Authority use only

Identification of IPEA	Date of receipt of DEMAND

Box No. I IDENTIFICATION OF THE INTERNATIONAL APPLICATION

Applicant's or agent's file reference: BP100152/SKU/PKK

International application No.	International filing date *(day/month/year)*	(Earliest) Priority date *(day/month/year)*
PCT/FI00/00796	20 September 2000 (20.09.00)	20 September 1999 (20.09.99)

Title of invention:
METHOD FOR DETERMINING A CANDIDATE FOR AN ACTIVE SET

Box No. II APPLICANT(S)

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)*

NOKIA NETWORKS OY
P.O. Box 300, FIN-00045 NOKIA GROUP, Finland

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Facsimile No.:

Teleprinter No.:

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SALONAHO, Oscar
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Finland	Finland

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)*

State *(that is, country)* of nationality:	State *(that is, country)* of residence:

☐ Further applicants are indicated on a continuation sheet.

Box No III AGENT OR COMMON REPRESENTATIVE; OR ADDRESS FOR CORRESPONDENCE

The following person is [x] agent [ ] common representative

and [x] has been appointed earlier and represents the applicant(s) also for international preliminary examination

[ ] is hereby appointed and any earlier appointment of (an) agent(s)/common representative is hereby revoked

[ ] is hereby appointed, specifically for the procedure before the International Preliminary Examining Authority, in addition to the agent(s)/common representative appointed earlier

Name and address: *(Family name followed by given name; for a legal entity, full official designation The address must include postal code and name of country)*

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[ ] **Address for correspondence:** Mark this check-box where no agent or common representative is/has been appointed and the space above is used instead to indicate a special addr ess to which correspondence should be sent

Box No IV BASIS FOR INTERNATIONAL PRELIMINARY EXAMINATION

Statement concerning amendments:*

1 The applicant wishes the international preliminary examination **to start on the basis of:**

[x] the international application as originally filed

the description
- [x] as originally filed
- [ ] as amended under Article 34

the claims
- [x] as originally filed
- [ ] as amended under Article 19 (together with any accompanying statement)
- [ ] as amended under Article 34

the drawings
- [x] as originally filed
- [ ] as amended under Article 34

2 [ ] The applicant wishes any amendment to the claims under Article 19 to be considered as reversed

3 [ ] The applicant wishes the start of the international preliminary examination **to be postponed** until the expiration of 20 months from the priority date unless the International Preliminary Examining Authority receives a copy of any amendments made under Article 19 or a notice from the applicant that he does not wish to make such amendments (Rule 69(d)) *(This check-box may be marked only where the time limit under Article 19 has not yet expired)*

* Where no check-box is marked, international preliminary examination will start on the basis of the international application as originally filed or, where a copy of amendments to the claims under Article 19 and/or amendments of the international application under Article 34 are received by the International Preliminary Examining Authority before it has begun to draw up a written opinion or the international preliminary examination report, as so amended

Language for the purposes of international preliminary examination: English

- [x] which is the language in which the international application was filed
- [x] which is the language of a translation furnished for the purposes of international search
- [x] which is the language of publication of the international application
- [ ] which is the language of the translation (to be) furnished for the purposes of international preliminary examination

Box No V ELECTION OF STATES

The applicant hereby **elects all eligible States** *(that is, all States which have been designated and which are bound by Chapter II of the PCT)*

excluding the following States which the applicant wishes **not to elect:**

Box No VI CHECK LIST

The demand is accompanied by the following elements, in the language referred to in Box No IV, for the purposes of international preliminary examination:			For International Preliminary Examining Authority use only: received	not received
1 translation of international application	:	sheets	☐	☐
2 amendments under Article 34	:	sheets	☐	☐
3 copy (or, where required, translation) of amendments under Article 19	:	sheets	☐	☐
4 copy (or, where required, translation) of statement under Article 19	:	sheets	☐	☐
5 letter	:	sheets	☐	☐
6 other *(specify)*	:	sheets	☐	☐

The demand is also accompanied by the item(s) marked below:

1 [X] fee calculation sheet

2 [ ] separate signed power of attorney

3 [ ] copy of general power of attorney; reference number, if any:

4 [ ] statement explaining lack of signature

5 [ ] nucleotide and or amino acid sequence listing in computer readable form

6 [ ] other *(specify)*:

Box No VII SIGNATURE OF APPLICANT, AGENT OR COMMON REPRESENTATIVE

Next to each signature, indicate the name of the person signing and the capacity in which the person signs (if such capacity is not obvious from reading the demand)

BERGGREN OY AB

Torolf Pelin
Patent Attorney

HELSINKI, Finland, 18 April 2001

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1 Date of actual receipt of DEMAND:

2 Adjusted date of receipt of demand due to CORRECTIONS under Rule 60.3(b):

3 [ ] The date of receipt of the demand is AFTER the expiration of 19 months from the priority date and item 4 or 5, below, does not apply [ ] The applicant has been informed accordingly

4 [ ] The date of receipt of the demand is WITHIN the period of 19 months from the priority date as extended by virtue of Rule 80.5

5 [ ] Although the date of receipt of the demand is after the expiration of 19 months from the priority date, the delay in arrival is EXCUSED pursuant to Rule 82

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Demand received from IPEA on:

CHAPTER II

PCT

FEE CALCULATION SHEET

Annex to the Demand for international preliminary examination

International application No	PCT/FI00/00796
Applicant's or agent's file reference	BP100152/SKU/PKK

For International Preliminary Examining Authority use only

Date stamp of the IPEA

Applicant

NOKIA NETWORKS OY

Calculation of prescribed fees

1 Preliminary examination fee	EUR 1533	P
2 Handling fee *(Applicants from certain States are entitled to a reduction of 75% of the handling fee. Where the applicant is (or all applicants are) so entitled, the amount to be entered at H is 25% of the handling fee)*	EUR 147	H
3 Total of prescribed fees Add the amounts entered at P and H and enter total in the TOTAL box	EUR 1680	TOTAL

Mode of Payment

[X]	authorization to charge deposit account with the IPEA (see below)	[ ]	cash
[ ]	cheque	[ ]	revenue stamps
[ ]	postal money order	[ ]	coupons
[ ]	bank draft	[ ]	other *(specify)*:

Deposit Account Authorization *(this mode of payment may not be available at all IPEAs)*

The IPEA/ EP [X] is hereby authorized to charge the total fees indicated above to my deposit account.

[ ] *(this check-box may be marked only if the conditions for deposit accounts of the IPEA so permit)* is hereby authorized to charge any deficiency or credit any overpayment in the total fees indicated above to my deposit account.

Berggren Oy Ab

28150004	18 April 2001	Pia Kulju, Patent Assistant
Deposit Account Number	Date *(day/month/year)*	Signature